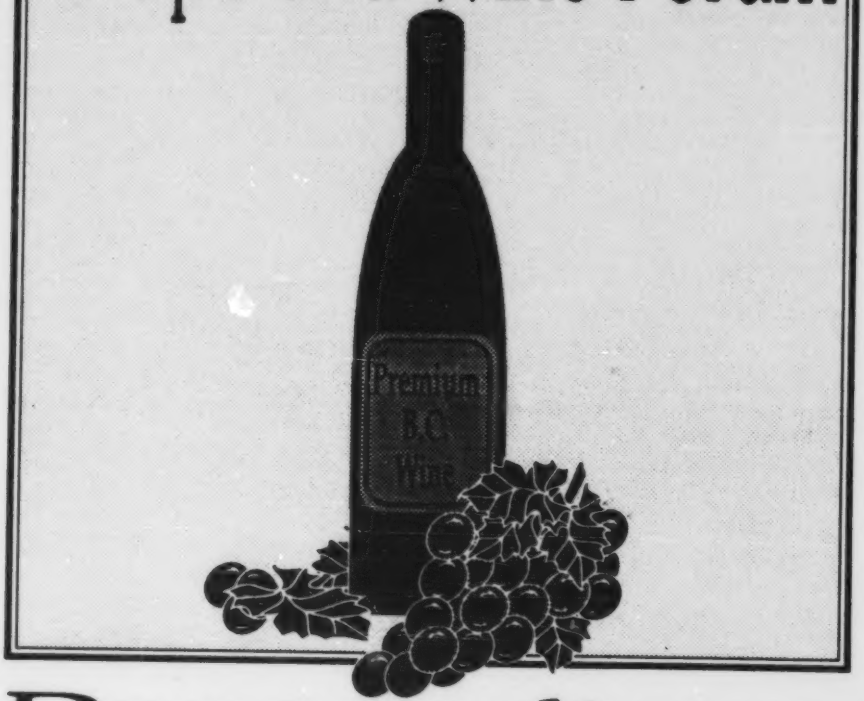
Grape and Wine Forum



Proceedings

July 25 & 26, 1991
Agriculture Canada, Research Station
Summerland, B.C.

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ACKNOWLEDGEMENTS

The 1991 grape forum provided grape growers and wineries with an educational program designed to focus on the production of quality grapes and quality wine. The theme for the forum was "Quality as Influenced by Crop Load and Irrigation".

This year's forum was sponsored by The British Columbia Wine Institute, together with the British Columbia Ministry of Agriculture, Fisheries and Food, the Viticulture Committee of the Association of British Columbia Grape Growers and the Agriculture Canada Research Station at Summerland.

We extend a sincere thank you to all the speakers; the wineries that made the wine tastings possible, and the behind the scenes help provided by so many people. Contact and arrangements with speakers, arrangements for a site to hold the forum and the wine tastings; arrangements for funding to pay all the bills; and printing of the proceedings are only a few of the activities that are needed to provide a forum of this kind.

Wines provided for the tasting of selected VQA wines were as follows:

Cedar Creek Estate Winery

Pinot Blanc
Pinot Auxerrois
Riesling
Gewurztraminer
Semillon

Wild Goose Farm Winery

Marechal Foch
Gewurztraminer
Riesling

Mission Hill Vineyards

Semillon
Chardonnay
Riesling
Chenin Blanc
Kuhlmann-Cabernet

Okanagan Vineyards

Bacchus
Mullet Thurgau
Gewurztraminer
Riesling

The Honorable Larry Chalmers, Minister, Ministry of Agriculture, Fisheries and Food made a short, and welcome address to the industry at the end of the program.

Mission Hill Vineyards presented a selection of wines and Steve Cypes of Pyramid Cellars presented some of his champagne at the end of the forum for the enjoyment of everyone.

The forum achieved its goal with the participation and attendance of the grape growers and wineries for whom this forum was designed. The response to this forum has been very favorable.

Best regards,

John Vielvoye, P.Ag.
Provincial Grape Industry Specialist
British Columbia Ministry of Agriculture, Fisheries and Food

BRITISH COLUMBIA WINE INSTITUTE

NOTICE TO ALL GRAPE GROWERS AND WINERIES

GRAPE FORUM

JULY 25 & 26 -1991

HELD AT

AGRICULTURE CANADA RESEARCH STATION--SUMMERLAND

WINE QUALITY
INFLUENCED BY CROP LOAD & IRRIGATION

WINE QUALITY BEGINS IN THE VINEYARD.

WE HOPE TO SEE YOU AT THIS YEARS FORUM

A REGISTRATION FORM IS ATTACHED. PLEASE RETURN IT AS SOON AS POSSIBLE.

YOUR PARTICIPATION IS IMPORTANT

REGARDS

Nick.

SUITE 5 • 1864 SPALL ROAD,
KELOWNA, B.C., CANADA V1Y • 4R1
PHONE 604 • 762 • 4887
FAX 604 • 862 • 8870

GRAPE FORUM

JULY 25 & 26 - 1991

WINE QUALITY INFLUENCED BY CROP LOAD & IRRIGATION

This year's grape forum is sponsored by the B.C. Wine Institute in cooperation with the Viticulture Committee; the B. C. Ministry of Agriculture, Fisheries and Food and Agriculture Canada Research Station - Summerland.

A registration form is attached. Please return it as soon as possible confirming your participation in this years forum.

July 25	8:30 - 9:15	Registration
	9:15 - 9:30	Opening of the Forum by John Vielvoye, Provincial Grape Industry Specialist, B. C. Ministry of Agriculture, Fisheries and Food.
	9:30 - 10:30	Dr. Andy Reynolds Research scientist at the Summerland Station, working exclusively for the grape and wine Industry of British Columbia. Dr. Reynolds will discuss his evaluation of wine quality influenced by crop load and canopy management.. The presentation will be followed by a Riesling tasting.
	10:30 - 11:30	Riesling tasting presented by Dr. Reynolds. This tasting is limited to 20 people; Crop load and canopy management on wine quality. Please refer to the attached registration form and sign up if you are interested in participating in this tasting and evaluation of experimental wines.
	10:30 - 11:30	Tour of Experimental Plantings by Doug Wardle. Report on ARDSA Planting by John Vielvoye.

July 25	11:30 - 12:30	Mr. Andrew Naylor Currently working on his doctorate at the Summerland Research Station, Mr. Naylor is from New Zealand and will present an update on his paper based on irrigation in cool climates. Mr. Naylor'spaper was presented at the Second World Cool Climate Symposium in 1988.
	12:30 - 13:30	Lunch
	13:30 - 14:15	Mr. Ray Johnson The most current catalogue, detailing certified suppliers of materials approved by Agriculture Canada, Plant Quarantine will be presented In the search for new materials Mr. Johnston will be discussing the quarantine process pertaining to the evaluation and indexing of virus diseases.
	14:15 - 15:15	Dr. Sara Spayd Viticulture Presentation: As the Food Scientist at the Irrigated Agriculture Research and Extention Cente in Washington State, Dr. Spayd has been invited to the forum to discuss the effect on wine quality as influenced by crop load and irrigation.
	15:15 - 16:15	Dr.. Charles Edwards Enology presentation: Dr. Edwards, one of the leading researchers in malolactic fermentations, is also from the Irrigated Agriculture Research and extension Center at Prosser, Washington. He will address research studies on malolactic fermentation and evaluation of various strains isolated and used to inoculate samples of Chardonnay, Cabernet and Merlot. Other studies to be discussed include evaluating the interactions between yeast and lactic acid bacteria.
	16:30 - 17:30	Mr. Harry McWatters A wine tasting of selected 1990 vintage VQA approved wines.

July 26	8:00 -	8:30	Registration
	8:15 -	8:30	Opening of the Forum by Mr. Doug Sperling President of the B.C.Grape Growers Association
	8:30 -	9:30	Mr. Steve Price Viticulture Presentation: Responsible for Viticulture Research and Extension at Oregon State University, Mr. Price will address Pinot Noir & Chardonnay grape production and clonal selection.
	9:30	10:30	Mr. Barney Watson Enology presentation: Mr. Watson, an enologist from Oregon State University, will discuss malolactic fermentation, barrel fermentation and barrel aging.
	10:30	11:30	Oregon wine tasting presented by Watson & Price This tasting is limited to 20 people; Please refer to the attached registration form and sign up if you are interested in participating in this tasting and evaluation of Oregon wines.
	10:30	11:15	Mr. Tim Watts The commercial application and use of contour mapping of sugar, acid, ph and variables in the vineyard for the assessment of grape maturity and improvement of grape quality.
	11:15	11:45	Dr. Sara Spayd Export opportunities: A Washington State study
	11:45	13:45	Lunch An opportunity to meet suppliers of equipment, materials, supplies and services at this years BBQ, hosted by your suppliers to the grape and wine industry.

July 26	13:45	14:45	Farm Winery Presentation

The BCLCB and the Farm Winery Association will present the "Step by Step" procedure, process and cost in starting a Farm Winery.

	14:45	15:45

Champagne Production

British Columbia is developing a champagne industry.

Ken Visser: Schramsberg Project at Inkameep
Daniel Lagnez: Champagne production at Mission Hill Vineyards
Eric von Krosigk: A new Champagne Winery in the Okanagan Valley at Summerhill Vineyards.

	15:45	16:30

Panel question period and discussion:

Dr. Andy Reynolds
Mr. Andrew Naylor
Mr. Ray Johnson
Dr. Sara Spayd
Dr.. Charles Edwards
Mr. Steve Price
Mr. Barney Watson
Mr. Tim Watts

16:30 - 16:45 The Honourable Larry Chalmers, Minister Ministry of Agriculture,Fisheries and food

Closing remarks

16:45 - 17:30 Experimental Wine Tasting Hosted by Mission Hill

REGISTRATION FOR GRAPE FORUM
JULY 25 & 26 - 1991

HELD AT AGRICULTURE CANADA RESEARCH STATION, SUMMERLAND

NAME _____

TELEPHONE _____

ADDRESS _____

_____

POSTAL CODE _____

FORUM:

NUMBER ATTENDING _____ X $25.00 AMOUNT ENCLOSED $ _____

LUNCHES:

NUMBER ATTENDING JULY 25 _____ X $ 5.00 AMOUNT ENCLOSED $ _____

NUMBER ATTENDING JULY 26 _____ NO CHARGE

WINE TASTINGS:

JULY 25 10:30 - 11:30 Riesling tasting presented by Dr. Reynolds.

This tasting is limited to 20 people;

NUMBER ATTENDING _____ X $15.00 AMOUNT ENCLOSED $ _____

JULY 26 11:00 - 12:00 Oregon wine tasting presented by Watson & Price

This tasting is limited to 20 people;

NUMBER ATTENDING _____ X $15.00 AMOUNT ENCLOSED $ _____

TOTAL AMOUNT ENCLOSED $ _____

RETURN WITH CHEQUE OR MONEY ORDER TO:

THE B. C. WINE INSTITUTE
5 -1864 SPALL ROAD
KELOWNA B.C.
V1Y 4R1

1991 GRAPE AND WINE FORUM EVALUATION

We need your help to evaluate this forum. Please give us your impressions and comments and complete this evaluation form.

The objective of this forum is to help you realize that wine and grape quality are the two most important ingredients to a healthy wine and grape industry. Did you receive that message from this forum ?

YES__41_____ No____0____

How useful were the topics in this program to you as a _____
This question was answered by the following

grape/wine grower	16
wine maker	3
grape grower/wine maker	9
no indication	12
amateur	4
interested party	1
total responses	45

There were 92 paid registrations for the forum. Total attendance including speakers and help was 120 people.

Evaluations of program content was based on very useful (immediate application) useful (application at an early date) reasonably useful (interesting and applicable at some time) and not useful (no application) Number of responses for each presentation and comments received do not total 45 because not all people attended all sessions and some people did not fill in all blanks The responses were as follows:

1) Wine quality as influenced by crop load and canopy management
very useful 21 useful 3 reasonably useful 11 not useful 0

2) Wine tasting illustrating the influence of crop load and canopy management (limited to 25 people)
very useful 10 useful 12 reasonably useful 3 not useful 0

3) Tour of Experimental plantings (canopy management)

very useful 9 useful 17 reasonably useful 7 not useful 0

4) Tour of the ARDSA project and see potential new varieties
very useful 5 useful 12 reasonably useful 10 not useful 2

5) Irrigation in cool climates in New Zealand
very useful 13 useful 12 reasonably useful 12 not useful 4

6) Wine quality -effect of crop load and irrigation in Washington.
very useful 17 useful 12 reasonably useful 11 not useful 1

7) Research studies on malolactic fermentation and various strains isolated to inoculate Chardonnay, Cabernet Sauvignon and Merlot in Washington
very useful 18 useful 18 reasonably useful 5 not useful 1

8) Wine tasting of recent approved V.Q.A. wines
very useful 16 useful 14 reasonably useful 8 not useful 0
fun 1

9) Oregon grape production
very useful 29 useful 8 reasonably useful 4 not useful 0

10) Oregon malolactic fermentations and wine production
very useful 25 useful 10 reasonably useful 4 not useful 0

11) Oregon wine tasting (limited to 20 people)
very useful 13 useful 3 reasonably useful 1 not useful 0

12) Commercial application and use of contour mapping
very useful 7 useful 14 reasonably useful 14 not useful 0

13) Export opportunities--a Washington State perspective
very useful 6 useful 14 reasonably useful 9 not useful 3

14) Lunch hosted by suppliers to the grape and wine industry
very useful 19 useful 18 reasonably useful 2 not useful 0
fun 1

15) Farm winery regulations and establishment of farm wineries
very useful 18 useful 17 reasonably useful 6 not useful 0

16) Champagne production

very useful 12 useful 21 reasonably useful 10 not useful 0

17) Panel question period and discussion
very useful 15 useful 18 reasonably useful 2 not useful 0

18) Experimental wine tasting hosted by Mission Hill
very useful 10 useful 14 reasonably useful 3 not useful 0

19) Should there be a forum in 1992 ?
YES 42 NO 1

20) If you answer to question 19 is yes indicated topics you would like to have in the program. If you answer is no, indicate your reasons. Suggestions for improvement are also welcome.

34 people made comments Their comments are divided into 4 groupings as follows:

Administration (7 people)
- more of the same
-more breaks
-have the forum in Feb. or March or August
-earlier notice
-raise the price to attend to cover more costs
-update this years information
-split sessions into one technical and one consumer oriented
-keep the Pacific North West Connection
-evening event to include wives with guest speaker

Grape/wine grower (18 people)
-seedless table grapes
-use of fertilizers
-water management
-winter hardiness
-site selection and effects on variety, rootstock etc.
-harvest criteria
-more viticulture
-soil management
-disease control including non pesticide
-phylloxera
-cover crop vs no cover crop
-rodent control

Wine (10 people)
-use of adjuncts in wine making
-white wine protocol
-improving wine quality
-wine, food, hospitality connection
-sensory evaluation
-more room at tastings
-aging requirements of wines
-

Grape/Wine grower and Wine Related (8 people)
-need independent lab for sugar, ph, acid determination
-varietal character-effects of wine making
-more practical wine making and grape growing information
-total quality management
-more information to tie grape/wine growing to wine quality
-physiological maturity indicators

SHOOT DENSITY: INTERACTIONS WITH CROP LEVEL AND CORDON AGE

A.G. Reynolds, D.A. Wardle, and M. Dever
Agriculture Canada Research Station,
Summerland, B.C.

Abstract

Three experiments were conducted in the Okanagan Valley of British Columbia between 1987 and 1990 to ascertain the impact of various shoot densities on vine performance and wine quality. Experiment 1, located in Kelowna, B.C., tested 3 shoot densities (16, 26, 36 shoots/m row) in combination with 3 crop levels (1, 1.5, 2 clusters/shoot) between 1987 and 1990. Weight of cane prunings (vine size), was decreased linearly by increased shoot density and crop level. Cane periderm formation was inhibited by increased shoot density, while vine winter damage was increased linearly by increasing crop level. Yield per vine, clusters per vine, and crop load (yield per unit of vine size) increased with increasing shoot density and crop level, while other yield components (cluster weight, berries per cluster, berry weight, clusters per shoot) tended to decrease. Soluble solids and pH were reduced linearly by increasing shoot density and crop level, but titratable acidity (TA) was less affected. Measurements of canopy density and leaf area suggested that fruit clusters may have been most exposed to sunlight at the 26 and 36 shoots/m treatments due to reduced lateral shoot growth and slightly smaller leaves. Monoterpene flavorants were not strongly influenced by either factor, but free volatile terpenes (FVT) were increased in berries and juices in 1989 with increasing shoot density, as were potentially volatile terpenes (PVT) in 1990. Tasters identified treatments from the lowest shoot densities and crop levels as having the most ripe fruit character, and the least green fruit flavor and perceived acidity. Shoot densities of 20 to 25 shoots/m row are recommended for low to moderately-vigorous Riesling vines to simultaneously acheive economically-acceptable yields and high wine quality.

Experiment 2, located at Similkameen Vineyards in Cawston, B.C., examined the impact of 3 shoot densities (20, 30, 40 shoots/m row) in combination with 3 cordon ages (year of establishment: 1983, 1986, 1987). No effect of either factor was observed on vine size. Periderm formation was inhibited by increased shoot density. Yield per vine, clusters per vine, and crop load increased with increasing shoot density, but cluster weight, berries per cluster, and berry weight displayed concomitant decreases. Old cordons (1983) were associated with higher yields and high cluster weights. Effects on fruit composition were minor, and tended to be associated with cordon age moreso than shoot density; for example, highest TA, FVT, and PVT were found in berries from 1983 cordons.

Canopy density increased linearly with increasing shoot density, but cordon age appeared to have no effect. Tasters found most fruity aroma and flavor in treatments from lowest shoot densities and oldest cordons, as well as the least grassy flavor and aroma. Our existing shoot density recommendations were confirmed based on these data.

Experiment 3 was located at Southview Farms, Okanagan Falls, B.C. in 1989, and was relocated to Boucherie Mountain Vineyards in 1990. It is an ongoing cooperative effort with Oregon State University (OSU). Experimental design consists of 3 canopy treatments (10 shoots/m row, 20 shoots/m row, Scott Henry with 10 shoots/m canopy) combined with 2 crop levels (full crop, half crop). The OSU experiment also includes a 15 shoots/m row treatment level. The 20 shoots/m row treatments were associated with higher yields, more clusters per vine, and higher crop loads than the 10 shoots/m row or Scott Henry treatments, along with lower cluster weights and berry weights. Reducing crop level led to slightly less yield per vine, but higher cluster weights and berry weights. The 20 shoots/m row treatments had lowest soluble solids and wine anthocyanins, but there was no effect on TA or pH. Reducing crop level increased soluble solids, TA, and wine anthocyanins. Tasters found that the 20 shoots/m row and the full crop treatments had more vegetative aroma and flavor. Since 10 shoots/m row produced acceptable yields (c. 8-9 mT/ha) along with superior wine quality, this shoot density is recommended for low to moderately-vigorous Pinot noir.

Introduction

A common question asked by grapegrowers is "how many buds should I leave"? In many cases, the answer is not a simple one, and, like most cultural operations, depends to some degree on vine vigor, spacing, and training system. However, many have attempted to provide guidelines with the basic objective of balancing vine vigor, yield, and fruit quality.

Partridge (1925) was perhaps the first to scientifically investigate this subject with his development of the "balanced pruning" concept on 'Concord' vines. In its simplest terms, balanced pruningis based on the premise that a vine must be pruned in accordance with its vigor. Partridge noticed that many of the vineyards he examined contained a range of vine sizes, from 0.1 to 6.9 pounds (0.05 to 3.14 kg) of cane prunings per vine. He found that by pruning large vines lightly (>50 nodes) and small vines severely (<30 nodes), yields and vine sizes gradually became more consistent. This concept was revisited by Shaulis and Robinson (1953), who recommended a 30+10 pruning formula (30 nodes for the first lb. of prunings and 10 nodes for each lb. thereafter) for 'Concord'. Other researchers modified this formula later on to account for different levels of fruitfulness, vine vigor, and average cluster sizes encountered in related cultivars such as 'Catawba', 'Fredonia', and 'Niagara'. This concept is still used today for *Vitis labruscana* cultivars.

French-American hybrids provided a different problem. When vines of 'De Chaunac', 'Seyval blanc', and other large-clustered cultivars were first planted, it became clear that their extremely-fruitful base shoots provided them with a serious propensity to overcrop. Modifications in balanced pruning formulae (Morris et al., 1984) tended to have little effect on crop regulation due to the productivity of non-count nodes. In many cases, severely-pruned 'Seyval blanc' vines got smaller due to the extra crop load imposed by these fruitful base shoots (R.M. Pool, pers. comm.). It was apparent that a strategy other than balanced pruning was required to maintain yield, vine size, and winegrape quality in large-clustered French-American hybrids.

Reynolds et al. (1986) first introduced the concepts of "shoot density" and "balanced thinning" for French-American hybrid grape production. They recommended 18 shoots/m of row and balanced thinning (of flower clusters) to obtain consistent yields in 'Seyval blanc'. Using this concept, all vines are pruned identically to obtain a desired leaf area and canopy density, then vines are cluster-thinned according to vine vigor; i.e. small vines are severely thinned (<1 cluster/shoot) and large vines are lightly thinned (c. 2 clusters/shoot).

Vitis vinifera have been the subject of surprisingly little investigation into optimum shoot density levels. Basler (1980; 1981) concluded that 5-6 and 6-7 shoots/sq. meter were optimal for 'Muller-Thurgau' and 'Blauburgunder', respectively. These translate to approximately 8-11 shoots/m of row. Smart (1988) indicated that 15 shoots/m of row was probably ideal for 'Gewurztraminer', based on canopy microclimate data. It should be pointed out that Smart's data were collected on very dense vines that had been shoot-adjusted at veraison, hence the effect of lateral shoot growth at different shoot densities could not express itself. Reynolds (1988) found that 25 shoots/m of row was equivalent to 30+10 balanced pruning of moderately-vigorous 'Riesling' vines in terms of vine size, yield, and fruit composition. Our recommendations for Vitis vinifera in B.C. are based on these data.

If we use the 15 to 25 shoots/m of row as a "point of departure", an interpolation of the literature would suggest that shoot densities below this range should lead to improved canopy microclimate, and all that it entails: high bud fruitfulness, optimum bud hardiness, high soluble solids, low TA and pH, enhanced varietal character, minimized vegetative flavors, and improved color. Shoot densities above this range lead to shaded canopies, and all that is associated with them: low bud fruitfulness, reduced winter hardiness, low soluble solids, high TA and pH, reduced varietal character, increased vegetative flavor, and poor color.

One may ask "has all the work been done" on shoot density effects on Vitis vinifera? The answer is a resounding no! There is insufficient data that may lead to practical shoot density guidelines for North American growing conditions, and there is no published work which examines interactions between shoot density and such things as crop level, cordon age and training system, to name a few. The general objectives of these studies were to

address the question of how moderate to high shoot densities interact with crop level, cordon age, and training system in terms of vine performance, canopy microclimate, fruit composition, and wine descriptors of 'Riesling' and 'Pinot noir' grapes.

MATERIALS AND METHODS

Experiment 1. This trial was located at Pioneer Vineyards, Ltd., Kelowna, B.C. The specific objectives were to assess the independent effects of shoot density and crop level, as well as their interactions, on vine performance and wine quality. 'Riesling' clone 21B Weis vines on 5C rootstock, planted in 1978, were trained to 0.7 m-high bilateral cordons and pruned to 2-node spurs. Spacing was 1.4m X 2.4m (vine X row) in east:west-oriented rows. Soil was a Glenmore clay loam (Kelley and Spilsbury, 1949). Irrigation was provided by overhead sprinklers.

Experimental design was a randomized complete block with 4 blocks and 5-vine treatment replicates. Three shoot densities (16, 26, and 36 shoots/m row) were combined in a factorial treatment arrangement with 3 crop levels (1, 1.5, 2 clusters/shoot) to provide 9 treatment combinations. Theoretical clusters per vine were the following:

	Crop level		
Shoot density	1	1.5	2
16	23	35	46
26	36	54	72
36	50	75	100

Data were collected from 1987 to 1990 inclusive. Data on vine size, yield components (yield/vine, clusters/vine, cluster weight, berries/cluster, berry weight, clusters/shoot, crop load), fruit composition (soluble solids, TA, pH) were collected each season. Other information compiled included periderm formation (1988), vine winter injury (1989), monoterpene flavorants (1989, 1990), leaf area components (1990), canopy density and characterization (1987, 1990), and fruit exposure (1990). Wines were made from all treatment combinations in 1989, using 15 kg of fruit per treatment replicate. Juice composition (soluble solids, TA, pH, FVT, PVT) and wine composition (ethanol, TA, pH) data were compiled in 1989. Wines were made in duplicate fermentations by keeping fruit from each block (replicate) in the field separate until after pressing, after which juice from blocks 1 and 2 and blocks 3 and 4 were respectively pooled together. Fermentations were carried out at 15C using Montrachet yeast.

Wines were tasted in February 1991 after 11 months of bottle age. Three aroma (ripe fruit, green fruit, corky/musty) descriptors and 4 flavor-by-mouth descriptors (ripe fruit, green fruit, sweetness, acidity) were developed through consensus by a 12-member taste panel. Intensity of each aroma and flavor descriptor was assessed on a 100-point line scoresheet.

Experiment 2. This experiment was conducted between 1987 and 1989 inclusive at Similkameen Vineyards, Cawston, B.C. Specific objectives were to asses the independent effects of shoot density and cordon age (ostensibly the amount of "old wood"), as well as their interactions, on 'Riesling' vine performance and wine quality. The high shoot densities used are close to those expected from mechanized pruning. 'Riesling' clone 21B Weis vines on SO4 rootstock, planted in 1978, were spaced 1.4m X 2.4 m (vine X row) in e:w-oriented rows. Vines were trained to a 0.6 m-high bilateral cordon and were pruned to 2-node spurs. Soil was a Similkameen silt loam (Kelley and Spilsbury, 1949). Irrigation was applied by overhead sprinklers. The vineyard floor was managed by clean cultivation.

Three shoot densities (20, 30, 40 shoots/m row) were combined with 3 cordon ages (establishment year: 1983, 1986, 1987) in a randomized complete block design with 4 blocks, 5-vine treatment replicates, and a factorialized treatment arrangement. This allowed for 9 treatment combinations. Shoot numbers per vine at the 3 shoot densities were 27, 41, and 54, respectively.

Data were collected from 1987 to 1989 inclusive on vine size, yield components (yield/vine, clusters/vine, cluster weight, berries/cluster, berry weight, crop load, clusters/shoot), and fruit composition (soluble solids, TA, pH). Other measurements included periderm development (1988), berry and juice terpenes (1989), juice composition (1989; soluble solids, TA, pH), wine composition (1989; ethanol, TA, pH), canopy density and characterization (1987), and cane and cordon carbohydrates (1988; analysis in progress).

Wines were made in 1989 from all treatment combinations, using 15 kg of fruit per treatment replicate. Duplicate fermentations were used, by separating fruit from each treatment replicate until after pressing, after which juice from treatments in blocks 1 and 2, and that from blocks 3 and 4 were, respectively, blended together. Fermentations were carried out at 15C using Steinberg yeast. Wines were tasted in February 1991 after 11 months of bottle age. Three aroma descriptors (fruity, grassy, candy) and 4 flavor-by-mouth descriptors (fruity, grassy, candy, sweetness), selected through consensus by 12 tasters, were used in the evaluation. A 100-point line scoresheet was used.

Experiment 3. This trial was begun as a cooperative venture between Oregon State University (OSU) and Agriculture Canada in 1989. The B.C. site in 1989 was located at Southview Farms, Okanagan Falls. Specific objectives were to assess the effects of shoot density and crop level on 'Pinot noir' vine performance and wine quality, but also to try to separate the effects of fruit environment and crop level through the observation of Scott Henry-

trained vines. 'Pinot noir' ('Spatburgunder') clone 91 Ritter on 5C rootstock, planted in 1986, were used, spaced 1.5m X 2.4m (vine X row) in n:s-oriented rows. Vines were initially trained to a 0.6 m-high bilateral cordon and pruned to 2-node spurs. Soil type was a Skaha gravelly sandy loam (Kelley and Spilsbury, 1949), the vineyard was clean-cultivated, and irrigation was provided by drip emitters. In 1990, the experiment was relocated to Boucherie Mountain Vineyards, Westbank, B.C. The Pinot noir clone was UCD clone 113 on SO4 rootstock, planted in 1987. Spacing and training were as in 1989, but rows were e:w-oriented. Soil type was an Oyama sandy loam (Kelley and Spilsbury, 1949), the vineyard was clean-cultivated, and irrigation was provided by overhead sprinklers.

The OSU experiment was located at the Woodhall Farm in Alpine, OR. Own-rooted 'Pinot noir' (Pommard clone) vines planted in 1984 were used, spaced at 1.8m X 2.7m (vine X row) in e:w-oriented rows. Vines were trained to the Guyot double system, were planted in Jory clay loam, unirrigated, and had permanent sod alleys. Other aspects of the OSU portion of this trial are discussed elsewhere in this Proceedings.

Experimental design consisted of 3 canopy treatments [10 shoots/m row, 20 shoots/m row, Scott Henry training (10 shoots/m canopy)] combined with 2 crop levels (full crop, half crop) in a randomized complete block design with 6 blocks, 4-vine treatment replicates, and a factorialized treatment arrangement. The OSU trial also contained a 15 shoots/m of row level. No Scott Henry treatments could be set up in B.C. in 1990 due to the problems in locating an alternate site to that used in 1989.

Data collected in 1989-90 included vine size, yield components (yield/vine, clusters/vine, cluster weight, berries/cluster, berry weight, clusters/shoot, crop load), and fruit composition (soluble solids, TA, pH, anthocyanins). Wines were made in 1989, and appropriate analyses were also done on the juices (soluble solids, TA, pH, anthocyanins, absorbance) and wines (ethanol, TA, pH, absorbance, anthocyanins). Fermentations were done in triplicate by initially separating 15 kg fruit lots from each treatment replicate, then blending wines from blocks 1 and 2, blocks 3 and 4, and blocks 5 and 6, respectively, following primary fermentation and subsequent pressing. Primary fermentation was carried out for 6 days at 35C, after which the essentially dry wines were pressed. Fermentation was completed in glass carboys at 20C. Pris de Mousse yeast was used for all fermentations.

RESULTS AND DISCUSSION

Experiment 1. **Growth, periderm, winter damage:** Vine size over the 4 years of observation ranged from 0.27 kg to 0.53 kg per vine (0.19 to 0.38 kg/m row), based on means of the main effects. This is considered low to moderate vigor. Generally, increasing shoot density and crop level decreased vine size in a linear fashion (Table 1). Means of 4 years averaged across all crop levels and shoot densities, respectively, were as follows:

Shoot density (shoots/m row)	Vine size (kg/vine)	Crop level (clusters/ shoot)	Vine size (kg/vine)
16	0.45	1	0.44
26	0.40	1.5	0.40
36	0.39	2	0.39

It is apparent from these data that increasing both shoot density and crop level may lead to a slight decrease in canopy density in low to moderate vigor vines on a long term basis.

Periderm is the brown waxy coating on grape canes which develops as the vines begin to undergo dormancy in late summer. Assessing its development can give us information on how well vines mature their canes, and can help us make conclusions regarding canopy microclimate. Data was collected on canes per vine with 0-3, 4-5, 6-9, and >10 ripened internodes per cane (4 categories), and was expressed as a percentage of total canes per vine. In general, crop level had no significant effect, and shoot density had no effect on % canes with 4-5 or 6-9 ripe internodes. However, as shoot density increased, the % canes with 0-3 ripe internodes increased, and the % canes with >10 ripe internodes decreased:

Shoot density (shoots/m row)	% 0-3	% <10
16	18.4	49.6
26	30.7	37.2
36	37.8	31.1

Poor periderm formation thus appears to be shade related, and may help account for vine size reductions which result from increased shoot density.

The February 1989 freeze gave us the opportunity to assess relative winter injury of the various teatments. A subjective scale was used:

0: Minor bud injury
1: One cordon lost or damaged
2: Both cordons lost or damaged; trunk intact
3: Total top loss; one trunk killed
4: Entire vine killed to soil level

Shoot density had no apparent effect (Table 1), but increasing crop level increased winter damage. The levels depicted in Table 1 are considered low in view of the severity of the winter. Winter damage thus appears to be related primarily to crop level, ie. reduced leaf area:crop ratio.

Canopy microclimate: Canopy microclimate was assessed by point quadrat analysis in 1987 and 1990. In 1987 (year 1), increasing shoot density led to denser canopies, but crop level had no effect:

Shoot density (shoots/m row)	Canopy contacts per insertion
16	2.2
26	3.0
36	4.2

Examined in more detail, lowering shoot density led to more canopy gaps and more fruit exposure. Increasing crop level increased fruit exposure, perhaps due to more clusters per vine in combination with lower individual shoot vigor. Up to 3 contacts per insertion is considered acceptable.

In 1990 (year 4), crop level appeared to have no effect whatsoever. Shoot density had similar results as in 1987 on total contacts and number of shaded leaves, but quadratic effects on fruit exposure (Table 2). All canopies in 1990 were too shaded.

It appears from these data that an increase from 16 to 26 shoots/m of row does not increase canopy shade. Maximum fruit exposure occurs at moderate (26 shoots/m row) densities, perhaps due to reduced leaf size and lateral shoot growth.

Leaf area components were measured in 1990. Increasing shoot density increased total leaf area per vine and leaf area per vine on main shoots. At the same time, leaf area per lateral shoot, leaf area on lateral shoots expressed on a per main shoot basis, and the ratio of main leaf:lateral leaf area decreased (Table 3). This is apparently a consequence of individual shoot devigoration, and helps account for the increase in fruit exposure observed with point quadrat analysis. The 16 shoots/m row treatments therefore produced longer laterals as a result of their vigorous shoots, plus, because their internodes were longer, their shoots were hedged somewhat more severely (c. 14 leaves). Thus, lower shoot densities (<16 shoots/m row) may lead to significant attenuation in canopy light levels--apparently equal to the addition of 10 more shoots/m of row.

Cluster exposure, in terms of photosynthetic photon flux density (PPFD) was measured randomly on 20 clusters per treatment replicate at hourly intervals on 28 August 1990 between 0900h and

1200h inclusive, using a quantum meter. Crop level had no independent effect, and shoot density had no effect at 3 of the 4 samplings. At 1100h, a significant shoot density X crop level interaction occurred:

Shoot density (shoots/m row)	Crop level (clusters/shoot) 1	1.5	2
16	35	16	8
26	7	14	9
36	19	45	36

Numbers are percentage of ambient PPFD at 1100h, 28 08 90. SED= 16.2.

These data appear to indicate that high fruit exposure may occur at high shoot densities, perhaps due simply to more clusters/vine, but perhaps also due to shoot devigoration and low lateral shoot development. The relatively low cluster exposure at the 16 shoots/m row level could also be related to lateral shoot growth.

Yield components: In general, increasing shoot density and crop levels increased yield/vine, clusters/vine, and crop load, and reduced cluster weight, berries/cluster, and berry weight (Tables 1, 4). Increasing shoot density also led to fewer clusters/shoot, suggesting that the increased canopy shade resulted in reduced fruitfulness (Table 4). The 16/1 and 36/2 combinations consistently gave the lowest and highest yields, respectively (Table 4a). Although the remaining 7 treatment combinations had theoretical clusters/vine ranging from 35 to 72, yield compensation caused their total yields to coalesce.

Fruit composition: Increasing shoot density and crop level reduced soluble solids (1989 excepted) and pH (Table 5). TA increased with increasing shoot density in 1987 and with increasing crop level in 1987 and 1988. All harvest indices were within acceptable ranges for 'Riesling' each year; ranges over 4 years for soluble solids, TA, and pH were:

Soluble solids	TA (g/liter)	pH
20.7-22.4	9.0-13.0	2.94-3.14

Increasing shoot density and crop level can thus be expected to reduce soluble solids and pH, and may increase TA. This is probably a consequence of delayed fruit maturity resulting from increased cluster number. The lack of consistent TA response at

low shoot densities may be a consequence of fruit shade caused by lateral shoots.

Monoterpene flavorants are generally responsible for the floral and muscat aromas in wine grapes such as 'Riesling' and 'Gewurztraminer'. They exist in 2 forms; either as free volatile terpenes (FVT), or as odorless polyols and diglucosides, hence potentially-volatile terpenes (PVT). The FVT are responsible for the flavor in the berries, and that of the juice immediately after pressing. PVT can release their free terpene precursors through enzyme treatment, must heating, skin contact, wine ageing, and through the use of specific yeasts (Strauss et al., 1986). 'Riesling' berries and juices are particularly rich in FVT and PVT.

Crop level had no apparent effect on monoterpene levels in either year, other than a slight quadratic effect on the juice PVT in 1989 (Table 6). Increasing shoot density increased berry and juice FVT in 1989 and berry PVT in 1990. This may be a result of more exposed fruit at higher shoot densities. Previous work with 'Gewurztraminer' associated higher FVT and PVT levels with naturally-occurring fruit exposure (Reynolds and Wardle, 1989b), or with treatments which led to higher fruit exposure (Reynolds and Wardle, 1989a).

Wine composition and sensory evaluation: Juices and wines tended to show the same trends displayed by the berry samples in 1989 (Table 6). In general, differences in juice composition between treatment combinations was very small, and ranges of soluble solids, TA, pH, FVT, and PVT were very narrow:

Soluble solids	TA (g/liter)	pH	FVT (mg/l)	PVT (mg/l)
22.4-23.3	9.3-10.2	2.82-2.98	1.11-1.32	1.53-1.77

The maximum and minimum values for each measurement did not necessarily correspond to highest and lowest yielding treatments, nor were yields substantially different between treatment combinations (Table 4a). It is also worth noting that berries and musts showed no significant response to shoot density or crop level in 1989 in terms of soluble solids, TA, and PVT (Tables 5, 6). These points are worth noting when rationalizing sensory data.

One might rationalize that wine quality should be best at the 26 shoots/m of row level due to low lateral shoot production, moderate yields, and high fruit exposure (as measured by point quadrat analysis). Others might argue that the 36 shoots/m of row treatments should have highest wine quality, despite high crop loads, as a consequence of low lateral shoot growth, high fruit exposure (measured by quantum meter), and high FVT levels. Prevailing popular opinion may dictate that the 16 shoots/m of row treatments should produce the best wines, although no aspect of our data would suggest this.

Tasters found no effect of shoot density on any of the aroma descriptors, but perceived a reduction in ripe fruit character relative to increased crop level (Table 7). Linear reductions in ripe fruit flavor and sweetness, and increases in green fruit flavor and perceived acidity, were associated with increased shoot density and crop level. Tasters also found the highest levels of

negative flavor-by-mouth descriptors (green fruit; acidity) and the lowest ripe fruit flavor in the 36 shoots/m of row treatments and in the 26/2 treatment (Table 7a). The absolute highest level of ripe fruit flavor character was found in the 16/1 treatment. There is some possibility that these flavor descriptors were biased by sweetness levels, but confirmation tastings such as that described in a separate article in these Proceedings indicate that this is probably not a major concern.

Since wine descriptors do not appear to be associated with any measured parameter of berry or juice composition, the focus must shift to other compounds such as 6-carbon aldehydes and alcohols that are responsible for the grassy and vegetative aromas and flavors. Large quantities of these C6 compounds may have been present in the high shoot density and high crop treatments, effectively masking varietal character associated with the terpenes. The small trends in soluble solids, TA, and pH may thus be indicative of much larger changes in flavor chemistry.

Experiment 2. **Vine size and periderm formation:** Vine size varied between 0.50 to 1.00 kg/vine (0.35 to 0.71 kg/m row). This is considered about ideal. There were no significant effects of either shoot density or cordon age (Table 1.1).

Cordon age also had no significant effect on periderm formation, and shoot density had no effect on % canes with 4-5 or 6-9 ripened internodes (Table 2.1). Shoot density had a similar effect as at the Kelowna site on % canes with 0-3 and >10 ripened internodes:

Shoot density (shoots/m row)	% canes in each category	
	0-3	>10
20	20.8	48.3
30	31.9	39.5
40	36.6	35.1

As shown by the Kelowna experiment, periderm formation appears to be dependent upon canopy light levels which are shoot density related.

Canopy microclimate: Total contacts per insertion were proportional to shoot density. Cordon age had no independent effect, but the negative effect of high shoot density (40 shoots/m row) was exacerbated when young cordons were used. Frequency of leaf contacts increased and that of clusters decreased with increasing shoot density:

Shoot density (shoots/m row)	Contacts per insertion
20	3.25
30	3.65
40	4.82

Since a value <3.00 is considered ideal, all these canopies would be considered too dense. However, the 20 and 30 shoots/m of row treatments were relatively close to this optimum. Canopy density increased minimally from 20 to 30 shoots/m of row, but dramatically from 30 to 40 shoots/m of row.

Yield components: Increasing shoot density increased yield/vine, clusters /vine, and crop load, but decreased cluster weight, berries/cluster, and berry weight (Tables 1.1, 3.1). Oldest cordons were associated with highest yields and cluster weights in 1987 and 1988, and most clusters/vine in 1988 (Table 3.1).

Fruit composition: Increasing shoot density reduced soluble solids in 1989 and increased TA in 1988, but differences were very subtle (Table 4.1). Increasing cordon age increased TA in each of 3 years, and reduced pH slightly in 1989 (Table 4.1). FVT were not affected by shoot density, but highest FVT in both the berries and juices were associated with oldest cordons (Table 5.1). PVT decreased with increasing shoot density, and highest PVT levels were also associated with oldest cordons (Table 5.1).

The increases in PVT and decreases in TA with reduced shoot density can be related to shade, but it is unclear why cordon age had such a significant effect on fruit composition. Koblet and Perret (1982) reported that vines carrying significant amounts of old wood produced fruit with higher soluble solids than those with no old wood. This was related to carbohydrate partitioning between the old wood and the berries, so presumably the old cordons represented a substantial carbohydrate reservoir.

Wine composition and sensory evaluation: Cordon age had no independent effect on aroma descriptors, and the "candy" aroma descriptor was unresponsive to cordon age and shoot density (Table 6.1). Fruity aroma tended to be reduced at the highest shoot density. Highest fruity flavor and lowest grassy flavor were associated with the oldest cordons. Among the many interactions, lowest fruity and highest grassy aromas occurred in the 40 shoots/m of row level on young cordons, as well as most grassy flavor.

Impacts of increasing shoot density on 'Riesling' vine performance and wine quality were mostly negative; major decreases

in PVT and unacceptable increases in canopy density occurred between 20 and 30 shoots/m of row. Increasing cordon age appears to have beneficial effects on yield, fruit composition, and wine quality; old cordons appear to "buffer" negative effects of higher shoot densities. Our recommendation based on these data is a shoot density of 20 shoots/m of row for moderately-vigorous 'Riesling' vines. If high shoot densities are anticipated, for example, through mechanical pruning, they should be coupled with older cordons.

Experiment 3. **Vine size:** There were no treatment effects in B.C. at either site (data not shown). Vine size ranges were 0.18 to 0.30 kg/vine (0.12 to 0.20 kg/m row) at Southview Farms and 0.50 to 0.79 kg/vine (0.33 to 0.53 kg/m row) at Boucherie Mountain. These ranges are considered low and ideal, respectively.

Yield components: Yields increased with increasing shoot density a both sites, and Scott Henry vines were equal to 10 shoots/m of row treatments in this respect (Table 1.2). This latter observation is partly due to shoot breakage, shoot devigoration, and the production of some weak, unfruitful shoots in the lower canopies of the Scott Henry vines. Cluster weights and berry weights were reduced by the 20 shoots/m of row and the Scott Henry treatments in 1989.

Reducing crop level had the expected effect: slightly reduced yield (1990), increased cluster weight, more berries/cluster (1989), and increased berry weight (1989). This was a consequence of yield compensation which resulted from lower cluster numbers in the low crop treatments.

Fruit composition: The 20 shoots/m of row treatments produced lowest soluble solids in the berries in 1989, but had no impact on TA and pH at either site (Table 2.2). In 1989, juice TA increased and pH decreased with the 20 shoots/m of row and Scott Henry treatments. Decreasing crop level increased berry and juice soluble solids in 1989, and decreased berry TA in 1990. Both the 10 shoots/m of row and the Scott Henry treatments gave best red color (A420) in the juice and highest juice color intensity (Table 3.2).

Wine composition and quality: The 10 shoots/m of row, Scott Henry, and half crop treatments increased wine anthocyanins (Table 3.2). There were also some small treatment differences on TA and pH. The 20 shoots/m of row and full crop treatments increased vegetative aroma in the wines, and the full crop treatments also had more vegetative flavor (Table 4.2). Interactions indicated that the 10/full crop and Scott Henry/half crop combinations had the least spicy/black pepper aroma, while the 10/half crop combination had the most astringence. Both the 10 shoots/m of row and the Scott Henry treatments produced excellent wines; fully-cropped Scott Henry vines produced the most complex wines, with high cherry aroma, low vegetativeness, high black pepper aroma, and moderate astringence. The 20 shoots/m of row treatments led to unacceptable vegetativeness in the wines. The 10/half crop

treatment produced 'Pinot noir' for long ageing.

CONCLUSIONS

Our recommendations of 20 to 25 shoots/m of row for 'Riesling' and similar medium-clustered Vitis vinifera ('Chardonnay', 'Pinot blanc', etc.) appear reasonable based on these data. Significant light attenuation in the canopies, coupled with reductions in wine quality, take place somewhere in the 20 to 30 shoots/m of row range. For 'Pinot noir', 10 shoots/m of row or canopy appears optimal to reduce vegetative character to acceptable levels.

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EXINAME: Table (R)P: (effect) 01

Table 1. Effect of shoot density and crop level on growth parameters of 'Riesling' vines, 1987-90.

Factor	Weight of cane prunings (kg/vine)				Shoots retained per vine				Vine damage	Crop load[u]	
	1987	1988	1989	1990	1987	1988	1989	1990	1989[z]	1989	1990
Shoot density											
16[y]	0.47	0.43	0.36	0.52	23.0	24.1	23.2	22.9	0.1	9.3	8.6
26	0.48	0.38	0.29	0.43	34.3	36.3	37.0	36.7	0.2	16.5	14.1
36	0.48	0.35	0.29	0.44	46.8	49.3	48.4	49.3	0.3	17.2	14.6
Significance[x,w]	NS	**l	*l	NS	***l	***l	***l	***l	NS	***l;**q	***l;**q
Crop level											
1[v]	0.46	0.41	0.36	0.53	34.3	37.2	36.3	36.5	0.0	11.0	9.7
1.5	0.46	0.37	0.30	0.45	35.5	36.6	37.1	37.4	0.3	16.4	13.2
2	0.51	0.36	0.27	0.41	35.5	37.0	35.5	36.1	0.3	16.1	14.7
Significance[x,w]	NS	NS	**l	**l	NS	*q	NS	NS	*l	***l;*q	***l
Interaction[x]	NS	NS	NS	NS	NS	*	NS	NS	NS	NS	NS

[z] 0=no damage; 1=one cordon damaged; 2=both cordons damaged; 3=toploss plus one trunk damaged; 4=vine killed to soil level.

[x] *,**,***,NS: Significant at $p < .05$, .01, or .001, or not significant, respectively.

[w] l,q: Linear or quadratic, respectively.

[v] Clusters per shoot.

[u] kg fruit per kg cane prunings.

EXTNAME: Quad (R)P: (III) 01

Table 2. Influence of shoot density and crop level on canopy density of 'Riesling' vines, 1990, as determined by point quadrat analysis.

Factor	Contacts per insertion	Exposed clusters	Partially-exposed clusters	Shaded leaves
Shoot density				
(Shoots per m of row)				
16	4.25	0.07	0.27	1.43
26	4.32	0.14	0.44	1.43
36	5.22	0.05	0.20	2.07
Significance[z],[y]	***l;*q	**q	***q	***l;*q
Crop level				
(Clusters per shoot)				
1	4.74	0.06	0.27	1.77
1.5	4.51	0.09	0.30	1.65
2	4.53	0.11	0.34	1.50
Significance[z],[y]	NS	NS	NS	NS
Interaction[z]	NS	NS	NS	NS

[z] *,**,***,NS = Significant at $p \leq .05$, .01, .001, or not significant, respectively.
[y] l,q: linear or quadratic, respectively.

Table 3. Effect of shoot density and crop level on leaf areaa of 'Riesling' vines, 1990.

Factor	Leaf area on main shoots (cm^2)			Leaf area on lateral shoots (cm^2)			Ratio[z]	Total[y] (cm^2)
	per leaf	per shoot	per vine	per lateral shoot	per main shoot	per vine		
Shoot density (shoots/m row)								
16	129.8	1689.4	38713.4	159.1	1959.2	45046.1	1.24	83759.5
26	113.4	1668.3	61017.5	68.9	1026.7	37131.4	0.60	98148.9
36	120.0	1922.4	94848.9	76.3	1258.5	62377.8	0.64	157226.7
Significance	NS	NS	***l	**l	*l	NS	**l	***l
Crop level (Clusters/shoot)								
1	125.5	1887.9	68906.4	86.7	1268.3	44168.4	0.66	113074.7
1.5	114.4	1687.6	62982.4	96.3	1443.3	49627.4	0.86	112609.9
2	123.1	1718.0	65323.1	119.4	1526.9	52249.1	0.95	117572.1
Significance	NS	NS	NS	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

[z] Ratio = leaf area per vine on lateral shoots/leaf area per vine on main shoots.
[y] Total = leaf area per vine on main shoots + leaf area per vine on lateral shoots.
[x] *,**,***,NS: Significant at $p \leq .05$, .01, .001, or not significant, respectively.
[w] l = Linear trend.

EXTNAME: shoot (R)P: (effect) 01

Table 4. Effect of shoot density and crop level on yield components of 'Riesling' vines, 1987-89.

	Yield ($t.ha^{-1}$)				Clusters/vine				Cluster wt. (g)				Berries/cluster				Clusters/shoot				Berry wt. (g)			
Factor	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
Shoot density																								
16[z]	7.8	14.3	9.2	10.9	34.7	35.3	33.9	33.9	74.0	139.2	95.2	113.4	53.2	86.4	60.7	71.6	1.5	1.5	1.5	1.5	1.36	1.60	1.54	1.58
26	10.4	16.8	11.4	14.4	50.2	51.8	51.3	52.9	71.4	111.2	78.1	96.3	51.2	72.0	52.0	64.7	1.5	1.4	1.4	1.4	1.36	1.53	1.49	1.49
36	14.0	19.4	12.0	16.5	71.8	70.7	62.5	68.4	66.4	94.8	67.5	84.3	50.0	62.2	46.2	58.8	1.5	1.4	1.3	1.4	1.30	1.51	1.45	1.43
Significance[y,x]	**l	***l	***l	***l,*q	***l,**q	***l	***l,*q	***l	NS	***l	***l	***l	NS	***l	***l	***l	NS	NS	***l	*l	NS	**l	**l	***l
Crop level																								
1[w]	8.4	13.5	10.2	12.4	36.0	36.8	36.3	36.7	75.8	127.2	97.7	118.0	55.1	78.8	62.3	76.8	1.0	1.0	1.0	1.0	1.36	1.61	1.56	1.54
1.5	10.2	17.2	11.7	14.3	54.1	53.4	51.9	54.2	67.5	115.3	80.3	92.2	49.1	73.2	53.0	60.8	1.5	1.5	1.4	1.5	1.33	1.55	1.50	1.51
2	13.8	20.0	10.9	15.4	68.7	69.2	61.1	65.8	67.9	101.1	60.7	82.4	49.9	67.6	42.6	56.9	1.9	1.9	1.8	1.8	1.33	1.49	1.42	1.44
Significance[y,x]	***l	***l	NS	***l	***l	***l	***l,*q	***l	NS	***l	***l	***L	NS	***l	***l	***l,*q	***l	***l	***l,*q	***l	NS	***l	***l	**l
Interaction[y]	*	NS	NS	**	***	***	NS	**	NS	*	NS	NS	*	*	NS	NS	NS	NS	**	NS	NS	NS	NS	NS

[z] Shoots per meter of row.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.
[w] Clusters per shoot.

EXTNAME: separate (R)P: 01

Table 4a. Yields (mt/ha) by treatment combination, 1987-90, 'Riesling'.

1987	Crop level		
Shoot density	1	1.5	2
16	4.3	9.5	9.4
26	8.9	10.2	12.1
36	11.3	10.8	19.7

SED = 11.54

1988	Crop level		
Shoot density	1	1.5	2
16	10.2	16.5	16.1
26	13.0	17.1	20.8
36	16.9	18.0	23.2

SED = 9.80

1989	Crop level		
Shoot density	1	1.5	2
16	7.8	11.2	8.6
26	9.9	12.5	12.0
36	12.5	11.4	12.1

SED = 5.43

1990	Crop level		
Shoot density	1	1.5	2
16	9.0	12.6	11.2
26	12.8	14.0	16.6
36	15.1	15.9	18.4

SED = 1.48

Table 5. Effect shoot density and crop level on fruit composition of 'Riesling' vines, 1987-90.

Factor	°Brix				Titratable acidity (g.liter^{-1})				pH			
	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
Shoot density												
16[z]	22.4	21.9	22.4	21.4	9.0	10.7	10.4	12.8	3.14	3.07	3.07	3.00
26	22.0	21.1	22.0	20.7	9.4	11.1	10.5	13.0	3.10	3.02	3.02	2.94
36	21.9	21.0	22.4	20.9	9.8	11.1	10.8	13.0	3.10	3.05	3.05	2.97
Significance[y,x]	*l	***l	NS	*l,q	***l	NS	NS	NS	**l	**q	**q	*l,**q
Crop level												
1[w]	22.4	22.0	22.4	21.4	9.3	10.6	10.6	12.8	3.14	3.09	3.07	3.01
1.5	22.2	21.2	22.1	20.8	9.5	11.2	10.6	13.0	3.11	3.05	3.04	2.96
2	21.8	20.7	22.2	20.8	9.5	11.1	10.5	12.9	3.09	3.01	3.03	2.94
Significance[y,x]	**l	***l	*q	**l	*l	*l	NS	NS	**l	***l	**l	***l
Interaction[y]	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	*	NS

[z] Shoots per meter of row.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.
[w] Clusters per shoot.

EXTNAME: Eleven (R)P: (shoot) 01

Table 6. Effect of shoot density and crop level on monoterpene content of 'Riesling' berries and juices, 1989-1990, and juice and wine, 1989.

Factor	Berries: Free volatile terpenes (FVT) ($mg.l^{-1}$)		Berries: Potentially-volatile terpenes (PVT) ($mg.l^{-1}$)		Juice					Wine	
					°Brix	TA($g.l^{-1}$)	pH	FVT ($mg.l^{-1}$)	PVT ($mg.l^{-1}$)	TA($g.l^{-1}$)	pH
	1989	1990	1989	1990							
Shoot density											
16[z]	0.73	0.65	2.33	1.99	23.1	9.6	2.96	1.17	1.66	6.94	3.27
26	0.87	0.65	2.25	1.08	22.8	10.0	2.89	1.17	1.59	6.87	3.31
36	1.07	0.66	2.35	2.25	22.9	9.8	2.93	1.27	1.64	6.82	3.28
Significance[y,x]	***l	NS	NS	**l	NS	NS	***q	*l	NS		
Crop level											
1	0.92	0.63	2.36	2.09	23.2	9.6	2.95	1.22	1.67	6.69	3.32
1.5	0.86	0.64	2.34	2.11	22.9	9.8	2.92	1.17	1.58	6.93	3.27
2	0.90	0.69	2.23	2.13	22.7	9.9	2.91	1.22	1.64	7.00	3.26
Significance	NS	NS	NS	NS	**l	NS	**l	NS	*q	***l,*q	**l
Interaction[y]	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

[z] Shoots per meter of row

[y] Significant at $p \leq .05$, .01, .001, or not significant, respectively

[x] l,q = Linear or quadratic, respectively

EXINAME: Table (R)P: 04

TEXTNAME: Quad (R)P: (III) 02

7509s

Table 7. Impact of shoot density and crop level on descriptors of 'Riesling wines', 1989.

Factor	Aroma descriptors			Flavor-by-mouth descriptors			
	Ripe fruit	Green fruit	Musty/corky	Ripe fruit	Green fruit	Sweetness	Acidity
Shoot density (Shoots/m row)							
16	32.9	22.8	19.5	44.7	13.5	45.3	38.9
26	29.3	21.4	18.2	35.2	21.0	38.1	41.7
36	32.6	21.5	17.5	25.4	34.0	24.8	55.3
Significance[y,x]	NS	NS	NS	***l	***l	***l	***l;**q
Crop level (Clusters/shoot)							
1	35.2	21.0	16.6	39.4	18.9	40.2	41.4
1.5	31.5	21.7	18.8	37.5	22.4	39.1	43.3
2	28.1	22.9	19.9	28.4	27.3	28.8	51.2
Significance[y,x]	**l	NS	NS	***l	***l	***l;**q	***l
Interaction[y]	NS	NS	NS	***	***	***	***
Interactions							
16/1				53.9	8.7	55.8	28.4
16/1.5				41.7	17.8	41.3	38.8
16/2				38.5	14.0	38.7	49.4
26/1				38.5	14.9	42.9	36.8
26/1.5				46.3	14.2	48.5	35.8
26/2				20.9	33.9	23.0	52.5
36/1				26.0	33.1	22.1	58.9
36/1.5				24.4	35.2	27.5	55.5
36/2				25.8	33.8	24.8	51.7
SED[y]				3.90***	4.23***	3.43***	4.46***

[z] Means based on a 100 point line scoresheet, 2 flights, with 12 tasters per flight.
[y] *,***,NS: Significant at p. $\leq$ .01, .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

Table 7a. Flavor-by-mouth descriptors, 'Riseling' wines, 1989.

RIPE FRUIT

Shoot density	Crop level 1	1.5	2
16	53.9	41.7	38.5
26	38.5	46.3	20.9
36	26.0	24.4	25.8

SED = 3.90

GREEN FRUIT

Shoot density	Crop level 1	1.5	2
16	8.7	17.8	14.0
26	14.9	14.2	33.9
36	33.1	35.2	33.8

SED = 4.23

SWEETNESS

Shoot density	Crop level 1	1.5	2
16	55.8	41.3	38.7
26	42.9	48.5	23.0
36	22.1	27.5	24.8

SED = 3.43

ACIDITY

Shoot density	Crop level 1	1.5	2
16	28.4	38.8	49.4
26	36.8	35.8	52.5
36	58.9	55.5	51.7

SED = 4.46

Table 1.1. Influence of shoot density and cordon age on growth parameters of 'Riesling' vines, 1987 to 1989.

	Weight of cane prunings (kg/vine)			Shoots retained per vine			Crop load (kg fruit/kg cane prunings)
Factor	1987	1988	1989	1987	1988	1989	1989
Shoot density[z]							
20	0.95	0.64	0.56	26.9	27.3	26.9	7.5
30	1.00	0.65	0.53	40.0	39.7	40.6	10.2
40	0.89	0.59	0.50	52.0	50.0	51.6	10.3
	NS	NS	NS	***l	***l	***l,*q	**l
Cordon age[w]							
1983	0.92	0.60	0.52	39.4	38.7	39.8	9.8
1986	0.96	0.62	0.54	39.9	39.9	39.8	8.7
1987	0.97	0.66	0.53	39.1	38.2	39.1	9.4
Significance[y,x]	NS	NS	NS	NS	*q	NS	NS
Interaction[y]	NS	NS	NS	**	NS	NS	NS

[z] Shoots per meter of row.
[y] *,**,***,NS: Significant at $p < .05$, .01, or .001, or not significant, respectively.
[x] l, q: Linear or quadratic, respectively.
[w] Year of establishment.

EXINAME: TABLE3 (R)P: 01

Table 2.1. Influence of shoot density and cordon age on periderm formation of 'Riesling' vines, 1987.

Factor	% of canes per vine in each maturity category			
	0-3	3-5	5-10	10
Shoot density[z]				
20	20.8	6.9	24.0	48.3
30	31.9	6.6	22.0	39.5
40	36.6	7.4	20.9	35.1
Significance[y,x]	***1	NS	NS	***1
Cordon age[w]				
1983	29.9	6.6	22.0	41.5
1986	30.0	7.2	22.6	40.2
1987	29.1	7.0	22.3	41.6
Significance[y,x]	NS	NS	NS	NS
Interaction[y]	NS	NS	NS	NS

[z] Shoots per meter of row.
[y] ***,NS: Significant at $p < .001$, or not significant, respectively.
[x] 1: Linear trend
[w] Year of establishment.

NAME: TABLE3 (R)P: 04

Table 3.1. Influence of shoot density and cordon age on yield components of 'Riesling' vines, 1987 to 1989

	Yield ($t.ha^{-1}$)			Clusters per vine			Cluster wt. (g)			Berries per cluster			Berry wt. (g)		
Factor	1987	1988	1989	1987	1988	1989	1987	1988	1989	1987	1988	1989	1987	1988	1989
Shoot density[z]															
20	21.6	8.8	12.5	65.8	48.3	50.4	113.0	62.2	78.8	81.1	46.5	50.3	1.39	1.34	1.56
30	25.1	10.2	15.8	84.0	67.4	72.1	102.6	52.0	71.1	71.6	39.7	46.1	1.43	1.31	1.55
40	24.7	10.3	15.5	99.4	75.6	81.6	84.7	46.7	61.0	64.2	36.5	40.5	1.32	1.28	1.51
Significance[y,x]	***l,**q	**l	*l	***l	***l,*q	***l	***l	***l	**l	***l	***l	***l	*q	*l	NS
Cordon age[w]															
1983	25.0	10.7	14.9	79.1	67.8	70.2	111.4	55.1	69.8	79.7	42.2	45.8	1.40	1.30	1.52
1986	23.2	9.3	14.1	79.5	61.6	65.4	100.5	53.0	70.3	72.2	39.7	45.2	1.39	1.33	1.55
1987	23.2	9.3	14.6	90.9	61.6	67.9	87.4	53.2	71.0	64.6	40.9	46.0	1.35	1.30	1.54
Significance[y,x]	*l	**l	NS	NS	***l	NS	NS	***l	NS	NS	NS	NS	NS	NS	NS
Interaction[y]	NS	NS	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] Shoots per meter of row.
[y] *,**,***,NS: Significant at $p < .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.
[w] Year of establishment.

Table 4.1. Influence of shoot density and cordon age on fruit composition of 'Riesling' berries, 1987 to 1989.

	°Brix			Titratable acidity (g.liter^{-1})			pH		
Factor	1987	1988	1989	1987	1988	1989	1987	1988	1989
Shoot density[z]									
20	18.8	22.3	24.7	8.9	9.3	9.3	3.44	3.35	3.15
30	18.7	22.1	24.5	9.0	9.5	9.7	3.43	3.31	3.14
40	18.0	21.9	24.0	9.0	9.5	9.5	3.44	3.32	3.13
Significance[y,x]	NS	NS	**l	NS	l*	NS	NS	NS	NS
Cordon age[w]									
1983	18.5	22.1	24.4	9.1	9.7	9.7	3.43	3.31	3.12
1986	18.6	22.2	24.3	8.9	9.3	9.5	3.44	3.33	3.15
1987	18.3	22.0	24.5	8.9	9.2	9.2	3.44	3.34	3.15
Significance[y,x]	NS	NS	NS	**l	**l	***l	NS	NS	*l
Interaction[y]	NS	NS	NS	NS	NS	**	NS	NS	NS

[z] Shoots per meter of row.
[y] ***,NS: Significant at $p < .001$, or not significant, respectively.
[x] l: Linear trend.
[w] Year of establishment.

Table 5.1. Impact of shoot density and cordon age on monoterpene content of 'Riesling' 21B berries and juices 1989, and on juice °Brix titratable acidity, and pH, 1989.

Factor	Free volatile terpenes (FVT) (mg.liter^{-1})		Potentially-volatile terpenes (PVT) (mg.liter^{-1})		Juice		
	Berry	Juice	Berry	Juice	°Brix	TA[W]	pH
Shoot density (shoots/m)							
20	0.60	1.12	1.74	1.02	25.0	8.4	3.22
30	0.58	1.11	1.59	0.98	24.4	8.7	3.22
40	0.62	1.18	1.58	0.96	23.6	8.7	3.20
Significance[Z,y]	NS	NS	*l	NS	***l	NS	NS
Cordon age[X]							
1983	0.73	1.15	1.73	1.10	25.2	9.1	3.19
1986	0.52	1.21	1.51	0.98	23.7	8.5	3.22
1987	0.54	1.06	1.67	0.89	24.0	8.2	3.21
Significance[Z,y]	***l,**q	*l,***q	**q	***l	**l,q	**l	*q
Interaction[Z]	NS	NS	NS	NS	NS	NS	NS

[Z] Significant at $p \leq .05$ (*), .01 (**), or .001 (***), or not significant (NS), respectively.
[y] Linear (l) or quadratic (q) trends, respectively.
[X] Year of establishment.
[W] Titratable acidity (g.l^{-1})

Table 6.1. Impact of cordon age and shoot density on 'Riesling' wine descriptors, 1989.

	Aroma descriptor			Flavor-by-mouth descriptor			
Factor	Fruity	Grassy	Candy	Fruity	Grassy	Candy	Sweetness
Cordon age[y]							
1983	33.8[z]	17.9	27.5	43.8	15.3	24.5	57.7
1986	32.6	16.6	22.9	36.3	23.4	18.1	38.4
1987	32.1	23.6	24.8	40.3	22.4	24.5	53.7
Significance[w,v]	NS	NS	NS	***q	**l,q	**q	*l;***q
Shoot density[x]							
20	31.8	19.6	25.0	40.3	18.9	24.6	55.1
30	37.8	17.7	25.1	40.7	20.9	22.4	49.0
40	29.6	20.4	25.5	40.2	20.2	20.9	47.9
Significance[w,v]	***q	NS	NS	NS	NS	NS	NS
Interaction[w]	*	**	NS	***	***	*	***
Interactions							
1983/20	28.8	16.5	31.3	39.3	17.1	23.5	55.5
1983/30	37.4	22.5	23.6	46.4	16.9	25.3	58.1
1983/40	35.4	14.8	27.5	45.7	11.8	24.7	59.6
1986/20	30.2	20.6	19.8	29.0	31.8	13.9	32.7
1986/30	39.1	14.4	25.0	34.2	26.3	19.8	39.1
1986/40	27.0	17.0	22.3	42.3	16.0	18.5	40.7
1987/20	35.7	22.2	21.3	46.8	14.2	31.0	65.9
1987/30	36.2	14.9	27.9	42.5	18.3	21.9	50.6
1987/40	26.4	29.4	26.6	32.8	32.7	19.4	43.0
SED[w,u]	6.93*	3.97**	NS	3.04***	3.57***	3.75*	3.65***

[z] Based on a 100-point line scoresheet.
[y] Year of cordon establishment.
[x] Shoots per meter of row.
[w] *,**,***,NS: Significant at p. < .05, .01, .001, or not significant, respectively.
[v] l,q: Linear or quadratic, respectively.
[u] SED = standard error of the difference.

Table 1.2 Impact of canopy treatment and crop level on yield components of 'Pinot noir', 1989-90.

Factor	Clusters/vine		Yield ($mT.ha^{-1}$)		Cluster wt. (g)		Berries/Cluster		Berry wt (g)	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Canopy treatment										
10 shoots/m	24.3 b	20.1 b	9.7 b	8.7 b	138.6 a	149.7	104.3	96.0	1.32 a	1.56
20 shoots/m	37.9 a	27.0 a	14.6 a	11.1 a	133.5 b	142.2	108.8	96.7	1.20 b	1.47
Scott-Henry[z]	28.2 b	----	10.1 b	----	128.2 b	----	109.1	----	1.17 b	----
Significance[y]	**	***	**	***	*	NS	NS	NS	**	NS
Crop level										
Full crop	37.0	31.2	12.5	12.4	115.6	136.7	96.7	91.7	1.17	1.49
Half crop	24.2	16.4	10.4	7.5	147.0	154.6	115.5	101.0	1.28	1.53
Significance[y]	***	***	NS	***	***	**	***	NS	**	NS
Interaction[y]	NS	NS	NS	NS	NS	NS	**	NS	NS	NS

[z] 10 shoots/m of subcanopy.

[y] *,**,***,NS: Significant at $p \leq .05$, .01, .001, or not significant, respectively.

[x] Means separated at p = .05 by Duncan's Multiple Range Test.

EXNAME: Impact (R)P: 02

Table 2.2 Impact of canopy treatment and crop level on fruit and juice composition of 'Pinot noir', 1989-90.

Factor	°Brix			Titratable acidity ($g.l^{-1}$)		pH			Juice (1989)		
	1989	1990	1991	1989	1990	1989	1990	1991	°Brix	TA	pH
Canopy treatment											
10 shoots/m	23.4 a	23.1		8.4	11.1	3.54	3.54		21.3	6.2 b	3.35 a
20 shoots/m	22.3 b	23.0		8.2	11.3	3.51	3.52		20.3	6.7 a	3.28 b
Scott-Henry[z]	23.3 a	----		8.5	----	3.50	----		20.8	6.7 a	3.29 b
Significance[y]	**	NS		NS	NS	NS	NS		NS	**	*
Crop level											
Full crop	22.8	22.9		8.3	10.9	3.51	3.53		20.5	6.4	3.29
Half crop	23.2	23.3		8.5	11.5	3.52	3.53		21.1	6.6	3.32
Significance[y]	*	NS		NS	**	NS	NS		*	NS	NS
Interaction[y]	NS	NS		*	NS	NS	NS		*	NS	NS

[z] 10 shoots/m of subcanopy.

[y] *,**,***,NS: Significant at $p \leq .05$, .01, .001, or not significant, respectively.

[x] Means separated at p = .05 by Duncan's Multiple Range Test.

EXTNAME: Impact (R)P: 03

Table 3.2. Impact of canopy treatment and crop level on aspects of berry, juice, and wine color of 'Pinot noir', 1990

Factor	Berry anthocyanins ($mg.liter^{-1}$)	Juice					Wine		
		Anthocyanins ($mg.liter^{-1}$)	A420	A520	Hue[z]	Intensity[z]	Titratable acidity ($g.liter^{-1}$)	pH	Anthocyanins ($mg.liter^{-1}$)
Canopy treatment									
10 shoots/m	98.5[y]	1.24	0.74a	0.36ab	2.04	1.10ab	6.4	3.73a	208.5a
20 shoots/m	84.1	0.16	0.60b	0.29b	2.13	0.89b	6.2	3.71a	179.7b
Scott Henry[w]	93.6	4.08	0.75a	0.42a	1.92	1.17a	6.3	3.64b	207.5a
Significance[x]	NS	NS	*	*	NS	*	NS	***	**
Crop level									
Full crop	93.7	1.93	0.67	0.36	1.94	1.03	6.1	3.67	179.6
Half crop	91.1	1.67	0.73	0.36	2.11	1.09	6.4	3.72	217.5
Significance[x]	NS	NS	NS	NS	NS	NS	**	**	***
Interaction[x]	NS	NS	NS	NS	NS	NS	***	NS	NS

[z] Hue = OD420/OD520; Intensity = OD420 + OD520

[y] Mean separation at $p \leq .05$, Duncan's Multiple Range Test.

[x] *,**,***,NS: Significant at p. = .05, .01, .001, or not significant, respectively.

[w] 10 shoots per m of subcanopy.

EXNAME: Table (R)P: (impact) 02

Table 4.2. Impact of shoot density, crop level, and Scott Henry training on 'Pinot noir' wine descriptors, 1989.

	Aroma descriptor				Flavor-by-mouth descriptor				
Factor	Cherry	Vegetative	Spicy	Caramel	Cherry	Vegetative	Spicy	Caramel	Astringent
Shoot density									
10 shoots/m row	34.7[z]	20.2 b	22.1	10.6 b	33.3	19.2	33.0	10.3	43.3
20 shoots/m row	31.5	25.5 a	25.6	15.4 a	31.9	22.2	28.3	11.3	39.3
Scott Henry	38.5	15.9 b	22.8	9.9 b	31.0	20.3	26.9	10.1	40.6
Significance[y]	NS	***	NS	*	NS	NS	NS	NS	NS
Crop level									
Full crop	33.1	22.8	23.7	13.2	30.8	23.2	28.3	11.2	40.1
Half crop	36.7	18.3	23.3	10.8	33.3	17.9	30.5	10.0	42.1
Significance[y]	NS	*	NS	NS	NS	*	NS	NS	NS
Interaction[y]	NS	NS	**	NS	NS	NS	NS	NS	*
Interactions									
10/full crop			17.1						37.8
10/half crop			27.1						48.8
20/full crop			29.3						41.6
20/half crop			21.9						36.9
Scott Henry/full crop			24.6						40.7
Scott Henry/half crop			21.0						40.5
SED[y]			4.24**						4.51*

[z] Based on a 100-point line scoresheet, 2 flights, with 12 tasters per flight.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, .001, or not significant, respectively.

RESULTS OF A RIESLING AND PINOT NOIR TASTING, GRAPE FORUM 1991

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A tasting of selected treatments from the experiments outlined in the previous article was conducted on 25 July for 20 tasters. The treatments selected were the following:

Riesling cl. 21B Weis; Pioneer Vineyards, Kelowna, B.C.

1. 16 shoots/m row; 1 cluster/shoot
2. 26 shoots/m row; 1.5 clusters/shoot
3. 36 shoots/m row; 2 clusters/shoot

Riesling cl. 21B Weis; Similkameen Vineyards, Cawston, B.C.

1. 20 shoots/m row; 1983 cordon
2. 30 shoots/m row; 1986 cordon
3. 40 shoots/m row; 1987 cordon

Pinot noir (Spatburgunder) cl. 91 Ritter; Southview Farms, Okanagan Falls, B.C.

1. 10 shoots/m row; full crop
2. 20 shoots/m row; full crop
3. 20 shoots/m row as a Scott Henry system (10 shoots/m canopy); full crop

Tasters were requested to evaluate the wines numerically on a 0-3 scale in terms of intensity of aroma, flavor-by-mouth, and sweetness (Rieslings only). They were also asked to comment on the wines by use of any relevant descriptors. The results of this tasting are presented in Table 1a to 1c. Results from the Research Station taste panels are presented in the overall shoot density article preceding this one.

Tasters found no significant differences in aroma intensity between the three Rieslings from Pioneer Vineyards, although a definite trend appeared to favor the low shoot density/low crop treatment (Table 1a). This trend was significant for flavor-by-mouth. Tasters indicated the 36 shoots/m treatment was least sweet as well. Common descriptors associated with the three treatments were ripe fruit, oxidized, fruity, and apple (16 shoots/m); vegetative, musty, and ripe fruit (26 shoots/m); and acidic, green fruit, and vegetative (36 shoots/m). A vegetative component thus was apparent in all the wines, but was the overwhelming descriptor at the high shoot density treatment. Some vegetativeness was apparent at the 26 shoots/m treatment as well, but not enough, so it seems, to impact negatively on aroma and flavor.

Tasters found no differences in aroma and flavor in the Rieslings from the Similkameen, although the trends were much like those from the Kelowna site (Table 1b). There was less perceived sweetness in the 40 shoots/m treatment. Common descriptors for the three wines were ripe fruit, fruity, and candy (20 shoots/m); ripe fruit, vegetative, apple, oxidized, and floral (30 shoots/m); and ripe fruit, vegetative, corky, bitter (40 shoots/m). No vegetative component was noted at the 20 shoots/m treatment, and although present in the other two wines, vegetativeness was cited less often than fruity descriptors. A candy descriptor was also indicated in the three wines.

The three Pinot noirs were judged to be not significantly different in terms of aroma and flavor (Table 1c). Common descriptors for the three wines were astringent/tannic/phenolic, cherry, and fruity (10 shoots/m); astringent/tannic and vegetative (20 shoots/m); and astringent/tannic and cherry (Scott Henry).

The tasters are thanked for their participation and interest. In many ways, their observations confirmed and strengthened those results that we obtained from our Research Station panel. Those results, and the inferences derived from them, are presented in the previous shoot density article.

Table 1. Wine scores and descriptors from Grape Forum tasting, 27 07 91. (a) Riesling, Pioneer Vineyards; (b) Riesling, Similkameen Vineyards; (c) Pinot noir, Southview Farms. Scores are means of 20 tasters. Numbers in parentheses following each descriptor indicate the number of times each descriptor was used. Means of aroma, flavor, and sweetness were separated by Duncan's Multiple Range Test, 5% level.

(a) Riesling clone 21B Weis 1989
Pioneer Vineyards, Kelowna, B.C.

	TREATMENTS		
	16 shoots/m; 1 cluster/shoot	26 shoots/m; 1.5 clusters/shoot	36 shoots/m; 2 clusters/shoot
Aroma	2.20 a	1.97 z	1.88 a
Flavor	2.45 A	2.23 AB	2.00 B
Sweetness	2.15 z	2.10 z	1.13 y
Descriptors	ripe fruit (5) oxidized; slight oxidation (5) fruity (4) apple (3) vegetative (2) harsh crisp intense tart caramel fragrant straw dry fruit; dry apple melons astringent caramel butter butyric floral perfumy	musty (6) vegetal; vegetative (6) ripe fruit (4) corky (2) rubbery (2) SO_2 (2) green fruit oxidized gunpowder aged fruit rich flavors sugary chemical fragrant light apples grassy	acidic (7) green fruit (6) vegetative (4) tannic/astringent (2) SO_2 (2) vanilla; oaky (2) slightly bitter sharp acid rich fruity aroma papery; cardboardy thin; sharp turpentine coarse; slightly harsh slightly green taste; intense aroma flowery light fruit; light floral; light herbaceous

(b) Riesling clone 21B Weis 1989
Similkameen Vineyards, Cawston, B.C.

	TREATMENTS		
	20 shoots/m; 1983 cordon	30 shoots/m; 1986 cordon	40 shoots/m; 1987 cordon
Aroma	2.10 a	2.05 a	1.95 a
Flavor	2.23 A	2.15 A	2.03 A
Sweetness	2.63 z	2.50 z	1.84 y
Descriptors	ripe fruit (8) fruity (7) candy (3) floral (2) apples (2) vanilla (2) apricots canned fruit melons spicy honey turpentine oily caramel low acid	ripe fruit (5) vegetative; vegetal (4) apple (4) oxidized (3) floral; flowery (2) honey plastic grapefruit bitter green fruit acetate straw moldy slight diacetyl fruity grassy musty candy	corky (4) ripe fruit (3) vegetative; vegetal (3) candy; cotton candy (2) bitter (3) musty (2 oxidized (2) rubbery (2) H_2S; SO_2 (2) old grass cuttings; grassy (2) herbal (2) tropical overripe burnt matches; gunpowder honey plastic thin melon turpentine cardboard applesauce green caramel

(c) Pinot noir (Spatburgunder) cl. 91 Ritter 1989
Southview Farms, Okanagan Falls, B.C.

	TREATMENTS		
	10 shoots/m; full crop	20 shoots/m; full crop	Scott Henry (20 shoots/m row); full crop
Aroma	1.88 a	1.76 a	1.86 a
Flavor	1.68 A	1.81 A	1.61 A
Descriptors	astringent; tannic phenolic (8) cherry; black cherry (4) fruity (3) berry; intense berry (2) oxidixed (2) chocolate (2) vegetative (2) old socks; tennis shoe (2) caramel coffee plummy black pepper green fruit little barn nail polish young	astringent; tannic (4) vegetative (4) herbal; herbaceous (2) cherry (2) green fruit black pepper plums intense berry caramel grassy fruity floral dirty socks rubbery solvent oxidized lacks aroma	astringent; tannic (7) cherry (3) berry; raspberries (2) fruity (2) green fruit vegetative bitter oxidized mercaptan dusty young low astringence

TOUR OF THE VITICULTURE RESEARCH PLOTS
AGRICULTURE CANADA RESEARCH STATION
SUMMERLAND, B.C.

Douglas A. Wardle and Andrew G. Reynolds
Agriculture Canada Research Station
Summerland, B.C.

Viticulture research at Summerland is dedicated towards two major thrusts: developing and evaluating viticultural practices that impact significantly on winegrape quality, and attempting to understand some of the physiology inherent in their implementation. The bulk of our research is focussed on the Vitis vinifera cultivars Riesling, Gewurztraminer, Chardonnay, and Pinot noir. Work is also underway with hybrids such as Seyval blanc and Chancellor. Ongoing on-station projects are as follows:

i) Vigor management

1. **Training system X vine spacing, Seyval blanc:** This cultivar is one of six hybrid cultivars that "survived free trade" and have been designated as "premium hybrids". Five training systems (high bilateral cordon; Geneva Double Curtain (GDC); midwire bilateral cordon; Y-trellis; 6-arm Kniffin) are combined with 3 vine spacings (1.4, 1.8, 2.4 m) in a factorial treatment arrangement with 4 blocks. We hope to accurately evaluate these various training/spacing combinations for vine growth, yield, fruit composition, and wine quality. We expect that the high vigor in this cultivar may be accomodated through canopy division, and that this may result in better fruit composition and higher wine quality. Results from 1988-90 indicate highest yields and lowest incidence of bunch rot in the GDC trellises, without any substantial reduction in fruit composition (Tables 1-3).

2. **Training system X vine spacing, Chancellor:** Chancellor is one of our most popular red cultivars. We are testing it with the same experimental design as is being used with the Seyval blanc. Chancellor also has a tendency towards excessive vigor, which we feel may be accomodated through canopy division and wider vine spacing. The 1988-90 results indicate that GDC training can increase yields substantially (>40 mT/ha) without any reduction in winegrape quality; anthocyanin content in the juice, in fact, is usually highest in the GDC berries(Tables 4-6).

3. **Training system X vine spacing X basal leaf removal, Riesling:** This is our most widely-planted white wine cultivar. Work is needed on methods which simultaneously reduce establishment and production costs, increase yields, and improve winegrape quality. This experiment tests some standard vertical trellises (low bilateral cordon; pendelbogen; Lenz Moser high cordon) along with two divided trellis systems (Alternate double crossarm (ADC); low V-trellis), in combination with three vine spacings (1.4, 1.8,

2.4 m) plus or minus basal leaf removal. The divided trellises appear to accomodate vigor extremely well, increase yields by 55%, and improve winegrape quality (including terpene flavorants). Wider vine spacing also seems to reduce individual shoot vigor to more reasonable levels. Basal leaf removal can improve fruit composition beyond those improvements observed in divided canopy systems. Data have been collected from 1988-90 (Tables 7-9). Details of this experiment are contained in the Proceedings from the 1990 Grape Forum.

Wines need to be made from all three trellis system trials within the next two or three years if time allows.

4. **Rootstock/Scion trial:** The threat of phylloxera may become evident in the Okanagan as more Vitis vinifera vineyards are planted. Rootstocks may be more useful, however, in controlling vine vigor, and hence may impact favorably on fruit composition. This large trial contains nine scion cultivars (Riesling; Chardonnay; Gewurztraminer; Ortega; Seyval blanc; Verdelet; Foch; De Chaunac; Okanagan Riesling) on five rootstocks (own-rooted; 3309; 5BB; 5C; SO 4), in a randomized complete block design with four blocks. Data collection began in 1989. We hope to see some differences in vine vigor, yield, and fruit composition as the vines mature. So far, we haven't seen any consistent differences, although it appears that 3309 gives us a smaller vine, perhaps due to this rootstock's inability to cope successfully with imposed water stress.

ii) Water relations and irrigation: There is one major experiment covered under this topic. The trial addresses the need to know some details about when to apply water, when to cut back, and how to manage the vineyard floor for most efficient water conservation. We are also interested in what irrigation/floor management combinations impact most favorably on winegrape quality and winter hardiness. This trial contains three irrigation deficit timings (post fruit-set; bunch closure; veraison) combined in a split-split plot with three floor management strategies (clean cultivated; total herbicide; permanent sod). Data will be collected beginning 1991. Several cooperators (E. Hogue; P. Parchomchuk; R. Berard) are addressing some of the details, such as soil water content and vine water relations. The details of the experimental layout are shown in Figure 1.

iii) Clonal evaluation: A section of our existing vineyard will be planted in 1992 with a Pinot noir clonal evaluation trial, containing seven named clones, replicated 4X. Clones evaluated will be those readily available to the industry in B.C.

Adjacent to the section designated for the clonal study is a Pinot noir block planted in 1989. It is presently a utility block; input from industry is invited on what research might be conducted in this block.

iv) Plant quarantine: Rupestris stempitting virus (RSPV) is presently a quarantinable virus for plant material entering the U.S. It is not a quarantinable virus in Canada; the opportunities for Canadian nurseries in the U.S are thus diminished. A trial at Summerland compares virus-free and RSPV-infected vines of Kerner (V. vinifera), Michurinetz (V. vinifera X V. amurensis), and Okanagan Riesling (V. labrusca X V. vinifera). No vine vigor or yield differences have been thus far obtained, however, RSPV appears to be associated with advanced fruit maturity, especially in Kerner and Okanagan Riesling (Table 10).

****

Data is collected each season, and throughout the season, on such things as weight of cane prunings, yield, fruit composition, and canopy density. Special, more detailed measurements are taken on terpene content of Riesling berries in the trellis trial, and anthocyanins in the Chancellor berries. In the irrigation trial, measurements are taken on soil water content, leaf proline, leaf water potential, and leaf transpiration rate.

Meetings and site visits from the industry at large are usually done on an annual basis. Data from the Riesling trellis trial have been presented in whole or in part at six meetings (Summerland; Cloverdale, B.C.; Pt. Townsend, WA; Penticton, B.C.; Rochester, NY; Seattle, WA).

Staff responsible include Dr. A. Reynolds (project leader); D.A. Wardle (technician); Drs. E. Hogue, P. Parchomchuk, and R. Berard (cooperators); W. Peters and J. Beulah (cooperating technicians).

Figure 1. Plot layout of the irrigation/vineyard floor management trial.

IRRIGATION-VINEYARD FLOOR MANAGEMENT TRIAL

Year of establishment: 1989.

Cultivar: Gewurztraminer on own roots. Riesling clone 21B Weis is used for the guard rows #1,5,9,13,17,21,and 22.

Treatments: Irrigation treatments consist of three water deficit timings: 1. Postbloom (PB); 2. Lag phase (full canopy development;LP); 3. Veraison (V). Each row is an irrigation treatment replicate. Floor management treatments consist of three treatments, randomized within each block in a split-plot arrangement. The treatments are: 1. Clean cultivated (CC); 2. Total herbicide (TH); 3. Sod alleys (SA). Guard rows and buffer plots are treated as TH treatments, and the guard rows are given PB irrigation treatment to avoid confounding of results. Each floor management treatment consists of two 3-vine plots per row.

Experimental design: A split plot experiment consisting of 3 irrigation regimes in combination with 3 vineyard floor management systems, replicated 5 times. There are 10, 3-vine postlength plots per row. End plots and those between floor management treatments are buffers. Guard rows separate each 3-row block. Vines are 2 m apart, rows are 3 m apart, posts are 6 m apart.

EXPERIMENTAL LAYOUT

BLOCK		I				II				III				IV				V			
ROW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	B	TH	TH	TH	B	SA	SA	SA	B	TH	TH	TH	B	CC	CC	CC	B	SA	SA	SA	B
	B	TH	TH	TH	B	SA	SA	SA	B	TH	TH	TH	B	CC	CC	CC	B	SA	SA	SA	B
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	B	CC	CC	CC	B	TH	TH	TH	B	CC	CC	CC	B	TH	TH	TH	B	CC	CC	CC	B
	B	CC	CC	CC	B	TH	TH	TH	B	CC	CC	CC	B	TH	TH	TH	B	CC	CC	CC	B
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	B	SA	SA	SA	B	CC	CC	CC	B	SA	SA	SA	B	SA	SA	SA	B	TH	TH	TH	B
	B	SA	SA	SA	B	CC	CC	CC	B	SA	SA	SA	B	SA	SA	SA	B	TH	TH	TH	B
	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
H2O		V	LP	PB		V	PB	LP		V	LP	PB		PB	LP	V		PB	LP	V	

EXINAME: effects (R)P: (reg) 04

Table 1. Effect of training system and vine spacing on growth parameters of 'Seyval blanc' vines, 1988 to 1990.

	Weight of cane prunings (kg)			Shoots retained per vine			% Budbreak	% Botrytis
Factor	1988	1989	1990	1988	1989	1990	1989	1990
Training system								
Geneva Double Curtain	0.48 b	0.62 b	0.70 c	57.6 a	28.3 ab	60.9 a	34.3 ab	13.0 b
Hudson River Umbrella	0.48 b	0.72 ab	0.99 bc	33.3 c	17.8 b	38.0 bc	32.3 ab	24.9 a
Midwire cordon	0.46 b	0.66 b	1.16 b	28.0 c	20.7 b	39.6 b	43.0 a	28.8 a
6-Arm Kniffin	0.47 b	0.81 ab	0.87 bc	40.9 b	19.4 b	34.1 c	44.3 a	18.8 ab
Y-trellis	0.78 a	0.92 a	1.52 a	58.5 a	33.1 a	63.5 a	23.1 b	23.4 a
Significance[y]	**	*	***	***	*	***	**	*
Vine spacing (m)								
1.2	0.47	0.67	0.93	34.2	18.0	34.4	32.6	22.6
1.8	0.53	0.76	1.03	41.3	25.6	46.4	36.8	20.6
2.4	0.58	0.80	1.21	54.1	27.2	61.6	37.6	21.9
Significance[y,x]	NS	NS	NS	***l	*l	***l	NS	NS
Interaction[y]	NS	NS	NS	**	NS	**	***	NS

[z] Means separated at the 5% level, Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

Table 2. Effect of training system and vine spacing on yield components of 'Seyval blanc' vines, 1988-1990.

Factor	Yield ($t.ha^{-1}$)			Clusters/vine			Cluster wt. (g)			Berries/cluster			Berry wt. (g)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990
Training system															
Geneva Double Curtain	21.5 a[z]	10.4	38.0 a	88.0 a	34.9	73.8 a	164.4 bc	188.5	245.3 b	145.0 b	120.8	170.3 b	1.11 ab	1.55 a	1.45 ab
Hudson River Umbrella	16.9 ab	8.2	26.8 bc	55.9 bc	26.3	44.6 b	199.2 a	199.0	290.0 a	170.0 a	129.3	192.3 a	1.16 ab	1.53 ab	1.51 a
Midwire cordon	13.0 b	8.1	18.2 d	48.2 c	26.8	40.0 b	178.7 ab	202.0	212.4 c	148.9 ab	136.5	170.4 b	1.20 a	1.46 ab	1.41 ab
6-Arm Kniffin	17.4 ab	9.7	24.0 c	70.8 b	33.4	46.5 b	157.7 bc	187.4	237.5 bc	142.7 b	132.2	151.1 c	1.12 ab	1.44 b	1.41 ab
Y-trellis	20.3 a	9.7	29.8 b	98.5 a	35.4	67.7 a	140.5 c	178.0	214.5 c	134.1 b	117.4	159.7 bc	1.04 b	1.53 ab	1.36 b
Significance[y]	**	NS	***	***	NS	***	**	NS	***	*	NS	**	*	*	*
Vine spacing (m)															
1.2	21.4	10.3	25.3	59.4	24.4	39.3	160.7	181.5	242.3	142.3	122.0	170.6	1.12	1.49	1.44
1.8	18.5	9.7	23.8	72.8	31.7	54.7	178.0	198.5	238.5	154.9	131.2	166.3	1.14	1.52	1.44
2.4	15.6	8.2	21.9	84.9	38.2	69.8	166.3	192.6	236.1	147.8	129.0	167.8	1.10	1.49	1.40
Significance[y,x]	**l	*l	***l	***l	*l	***l	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction[y]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] Means separated at the 5% level, Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

EXINAME: effects (R)P: (14) 05

EXINAME: effects (R)P: (reg) 06

Table 3. Effect of training system and vine spacing on fruit composition of 'Seyval blanc' grapes, 1988-1990.

Factor	°Brix			Titratable acidity ($g.l^{-1}$)			pH		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Training system									
Geneva Double Curtain	19.8 b	22.3 b	21.3 c	11.4	12.1 ab	11.5 b	3.10 c	3.23 b	3.33 b
Hudson River Umbrella	20.0 ab	22.8 ab	22.2 b	11.7	12.6 a	12.1 b	3.12 c	3.23 b	3.34 b
Midwire cordon	20.5 a	23.2 a	22.2 b	11.2	11.2 b	12.2 ab	3.20 a	3.30 a	3.37 ab
6-Arm Kniffin	20.2 ab	22.8 ab	23.1 a	11.6	11.5 b	12.3 ab	3.13 bc	3.27 ab	3.40 a
Y-trellis	20.7 a	22.8 ab	22.8 ab	12.1	11.8 ab	13.1 a	3.16 b	3.27 ab	3.37 ab
Significance[y]	*	*	***	NS	*	**	***	**	*
Vine spacing (m)									
1.2	20.3	22.7	22.5	11.9	12.4	12.6	3.15	3.27	3.37
1.8	20.3	22.5	22.3	11.4	11.7	12.3	3.14	3.24	3.35
2.4	20.1	23.0	22.1	11.5	11.4	11.8	3.14	3.27	3.36
Significance[y,x]	NS	NS	NS	NS	*l	**l	NS	NS	NS
Interaction[y]	NS	NS	NS	**	NS	NS	**	NS	NS

[z] Means separated at the 5% level, Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \geq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

EXTNAME: effects (R)P: (reg) 01

Table 4. Effect of training system and vine spacing on growth parameters of 'Chancellor' vines, 1988 to 1990.

Factor	Weight of cane prunings (kg)			Shoots retained per vine		
	1988	1989	1990	1988	1989	1990
Training system						
Geneva Double Curtain	0.56	0.74	1.30 b	58.2 a	57.5 b	73.8 a
Hudson River Umbrella	0.67	0.74	1.43 b	32.4 c	28.9 c	37.9 c
Midwire cordon	0.62	0.88	1.49 b	33.2 c	31.7 c	36.4 c
6-Arm Kniffin	0.65	0.78	1.63 ab	39.5 b	33.3 c	64.9 b
Y-trellis	0.79	0.90	2.04 a	60.4 a	62.6 a	66.0 b
Significance[y]	NS	NS	**	***	***	***
Vine spacing (m)						
1.2	0.60	0.77	1.38	30.3	27.8	41.7
1.8	0.64	0.66	1.49	46.0	40.4	53.0
2.4	0.73	1.00	1.87	53.3	58.3	71.6
Significance[y],[x]	NS	*q	**l	***l	***l	***l;*q
Interaction[y]	NS	NS	NS	**	***	**

z Means separated at the 5% level, Duncan's Multiple Range Test.

y *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.

x l,q: Linear or quadratic, respectively.

Table 5. Effect of training system and vine spacing on yield components of 'Chancellor' vines, 1988-1989.

Factor	Yield ($t.ha^{-1}$)			Clusters/vine			Cluster wt. (g)			Berries/cluster			Berry wt. (g)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990
Training system															
Geneva Double Curtain	21.3 ab[z]	20.2 a	41.7 a	73.0 b	70.6 a	87.7 a	190.9 b	195.7 ab	217.6 a	117.1 b	122.5 ab	142.4 ab	1.62	1.60 ab	1.53 a
Hudson River Umbrella	18.8 bc	12.1 bc	23.9 d	57.2 c	37.7 b	47.2 c	215.9 a	196.2 ab	233.1 a	130.1 a	120.8 ab	154.6 ab	1.63	1.64 a	1.52 ab
Midwire cordon	15.2 c	10.8 c	20.0 d	55.4 c	38.1 b	44.2 c	181.7 b	187.0 ab	208.6 ab	115.3 b	124.5 ab	162.3 a	1.60	1.49 c	1.45 bc
6-Arm Kniffin	19.5 abc	14.7 bc	36.4 b	71.8 b	44.8 b	73.1 b	177.7 b	218.0 a	235.1 a	112.8 b	141.6 a	144.8 ab	1.59	1.53 bc	1.44 c
Y-trellis	24.2 a	17.3 ab	28.8 c	102.8 a	71.7 a	73.3 b	155.4 c	150.6 b	184.7 b	97.0 c	102.1 b	132.9 b	1.61	1.44 c	1.40 c
Significance[y]	**	**	***	***	***	***	***	*	**	***	*	*	NS	***	**
Vine spacing (m)															
1.2	20.7	15.6	26.7	51.8	34.6	47.5	179.2	197.7	204.0	113.4	130.5	142.3	1.59	1.52	1.45
1.8	20.7	13.3	24.0	77.7	48.4	60.7	179.2	175.5	214.9	113.2	112.2	145.8	1.57	1.54	1.48
2.4	18.2	15.7	26.2	87.1	72.9	86.3	188.0	196.9	227.5	114.1	125.7	154.0	1.65	1.56	1.48
Significance[y,x]	***l	***l	***l;*q	***l	***l	***l;**q	NS	NS	NS	NS	*q	NS	NS	NS	NS
Interaction[y]	NS	*	NS	NS	**	NS	NS	*	NS	NS	*	NS	NS	NS	NS

[z] Means separated at the 5% level, Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \geq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

EXPANS: effects (R)P: (14) 02

Table 6. Effect of training system and vine spacing on fruit composition of 'Chancellor' grapes, 1988-1990.

Factor	°Brix			Titratable acidity ($g.l^{-1}$)			pH			Anthocyanins ($mg.l^{-1}$)		
	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990
Training system												
Geneva Double Curtain	19.4	22.6	19.9 b	12.2	12.7	14.6 b	3.30 a	3.22 c	3.12 b	493.5 a	990.9 a	830.3 a
Hudson River Umbrella	19.6	23.2	21.4 a	12.5	12.8	15.7 a	3.30 a	3.26 bc	3.14 b	435.5 ab	979.6 a	640.4 b
Midwire cordon	19.3	23.0	20.3 b	12.9	12.8	15.4 ab	3.28 ab	3.33 a	3.15 b	391.0 b	823.2 b	862.3 a
6-Arm Kniffin	19.3	22.8	21.4 a	13.0	12.6	16.0 a	3.24 b	3.29 ab	3.18 a	393.1 b	899.7 ab	524.6 b
Y-trellis	18.5	22.5	21.2 a	12.7	12.5	15.5 ab	3.26 ab	3.30 a	3.18 a	390.3 b	898.2 ab	827.2 a
Significance[y]	NS	NS	***	NS	NS	*	*	***	***	**	**	***
Vine spacing (m)												
1.2	19.4	22.9	20.8	13.2	12.7	15.7	3.28	3.30	3.16	431.2	922.4	762.0
1.8	19.2	23.0	21.0	12.7	12.4	15.5	3.27	3.28	3.16	434.9	928.1	786.9
2.4	19.1	22.6	20.7	12.1	12.9	15.1	3.28	3.27	3.15	404.2	904.4	722.2
Significance[y,x]	NS	NS	NS	**l	NS	NS	NS	*l	NS	NS	NS	*q
Interaction[y]	NS	NS	**	NS	NS	NS	NS	NS	NS	NS	NS	***

[z] Means separated at the 5% level, Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

EDWARE: effects (R)P: (11) 03

Table 7. Effect of training system and vine spacing on growth parameters of Riesling vines, 1988-91.

Factor	Weight of cane prunings (kg)			Shoots retained per vine			Vine damage	Count shoots per vine	Noncount shoots per vine	% Budbreak	Pruning time (min/vine)	Tying time (min/vine)
	1988	1989	1990	1988	1989	1990	1989[z]	1989	1989	1989	1991	1991
Training System												
Alternate double crossarm	1.13 bc[y]	0.66 b	1.81 b	61.5 a	23.9 b	57.5a	2.5 a	23.1 ab	14.2 b	21.7 bc	5.57 a	3.81 a
Lenz Moser	0.91 c	0.51 b	1.13 c	27.2 c	10.3 b	26.4b	2.5 a	6.4 c	6.3 b	15.9 c	2.23 c	0.53 b
Low cordon	1.30 ab	1.15 a	1.67 b	31.6 c	17.4 b	30.1b	1.3 b	12.3 bc	13.9 b	38.3 ab	2.84 bc	0.29 b
Pendelbogen	1.02 c	0.73 b	1.17 c	30.3 c	16.0 b	32.9b	1.9 ab	14.1 bc	4.0 b	28.4 bc	3.04 b	1.25 b
V-trellis	1.44 a	1.39 a	2.61 a	53.2 b	43.1 a	60.8a	0.9 b	31.6 a	27.1 a	56.5 a	5.46 a	0.77 b
Significance[x]	***	***	***	***	***	***	**	**	***	***	***	***
Vine spacing (m)												
1.2	0.92	0.64	1.35	28.6	14.5	30.7	2.0	10.5	9.8	28.7	3.24	1.17
1.8	1.20	0.88	1.65	40.6	19.9	41.0	1.8	15.0	13.6	31.7	3.64	1.42
2.4	1.35	1.13	2.02	50.6	31.6	52.8	1.7	26.6	15.6	35.5	4.58	1.40
Significance[x,w]	***l	**l	***l	***l	***l	***l	NS	**l	NS	NS	***l	NS
Interaction[x]	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

z Legend: 0 = no damage; 1 = one cordon damaged; 2 = both cordons damaged; 3 = top loss plus one trunk lost; 4 = vine killed to soil level.

y Means separated at the 5% level by Duncan's Multiple Range Test.

x *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.

w l,q: Linear or quadratic, respectively.

EXINMS: fourteen (R)P: (effect) 01

Table 8. Effect of training system and vine spacing on yield components of Riesling vines, 1988-90.

Factor	Yield ($t.ha^{-1}$)			Clusters/vine			Cluster wt. (g)			Berries/cluster			Berry wt. (g)			Crop load (kg fruit/kg cane prunings)
	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1989	1990	1990
Training System																
Alternate double crossarm	21.6 a[z]	14.7 a	27.8a	143.6 a	98.4 a	130.8a	101.4 bc	95.5 b	99.2bc	84.3 b	71.4 b	75.6 bc	1.22 c	1.31 c	1.33 b	7.8 a
Lenz Moser	12.6 b	7.1 b	14.9b	70.3 c	37.1 b	59.9c	119.1 a	121.7 a	119.8a	95.9 a	83.9 a	85.4 a	1.25 bc	1.44 ab	1.40 a	6.7 ab
Low cordon	14.4 b	8.9 b	16.9 b	83.6 c	47.5 b	73.4 bc	112.9 ab	123.2 a	108.0 b	81.9 bc	82.1 ab	79.0 ab	1.39 a	1.50 a	1.37 ab	5.1 b
Pendelbogen	14.2 b	8.4 b	18.5 b	79.5 c	46.0 b	84.2 b	116.5 a	121.4 a	104.4 bc	89.3 ab	85.8 a	78.1 ab	1.29 abc	1.43 ab	1.34 ab	8.0 a
V-trellis	19.0 a	14.6 a	27.9 a	121.7 b	95.1 a	133.3 a	100.6 c	98.0 b	95.4 c	74.2 c	71.7 b	68.6 c	1.35 ab	1.42 b	1.39 a	6.1 ab
Significance[y]	***	***	***	***	***	***	**	**	***	***	*	**	***	**	*	*
Vine spacing (m)																
1.2	16.8	10.2	19.9	68.4	41.1	72.1	108.0	114.3	103.3	84.7	81.4	76.0	1.28	1.41	1.36	6.0
1.8	16.0	8.2	18.2	101.4	50.1	96.4	105.8	106.0	106.1	81.9	73.1	78.4	1.31	1.43	1.35	7.3
2.4	16.2	13.2	16.9	128.0	106.4	119.3	116.0	115.4	106.8	88.4	82.2	77.7	1.32	1.42	1.38	7.0
Significance[y,x]	***l	***q	***l	***l	***l	***l	NS	*	NS	NS	**q	NS	NS	NS	NS	NS
Interaction[y]	NS	NS	NS	*	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[z] Means separated at the 5% level by Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

Table 9. Effect of training system, vine spacing and basal leaf removal on °Brix, titratable acidity, and pH of Riesling fruit, 1988-90.

Factor	°Brix			Titratable acidity (g.liter^{-1})			pH			Free volatile terpenes mg.liter^{-1}		Potentially-volatile terpenes mg.liter^{-1}	
	1988	1989	1990	1988	1989	1990	1988	1989	1990	1988	1990	1988	1990
Training System													
Alternate double crossarm	16.5c	21.1a	19.3bc	10.8b	12.3b	13.6b	3.16c	3.06c	3.04b	1.11a	0.66b	2.94a	2.07
Lenz Moser	17.3b	20.5b	19.8ab	11.5a	14.1a	13.9ab	3.15a	3.01d	3.04b	0.85c	0.69b	2.10c	2.04
Low cordon	18.4a	20.8ab	20.3a	10.8b	12.1b	13.7ab	3.26a	3.13a	3.09a	0.98b	0.83a	2.63ab	2.23
Pendelbogen	17.8ab	20.3b	19.2c	11.1ab	12.5b	13.7ab	3.22ab	3.05c	3.05b	1.07a	0.70b	2.56b	2.10
V-trellis	17.7ab	21.0a	19.8ab	10.9b	12.4b	14.2a	3.21b	3.09b	3.06ab	0.97b	0.69b	2.17c	2.06
Significance[y]	***	**	***	**	***	*	***	***	*	***	***	***	NS
Vine spacing (m)													
1.2	17.7	21.1	19.8	10.9	12.4	13.8	3.22	3.10	3.08	0.97	0.76	2.52	2.03
1.8	17.7	20.8	19.7	11.0	12.7	13.9	3.21	3.08	3.06	1.01	0.74	2.43	2.03
2.4	17.3	20.4	19.6	11.2	12.8	13.8	3.17	3.04	3.04	0.97	0.65	2.50	2.23
Significance[y,x]	NS	**l	NS	NS	NS	NS	***l	***l	**l	NS	***l	NS	**l
Basal leaf removal													
Control	17.7	20.9	19.8	11.2	13.0	14.1	3.20	3.07	3.05	0.99	0.73	2.28	1.93
Leaf removal	17.5	20.6	19.6	10.9	12.3	13.6	3.20	3.08	3.06	0.98	0.70	2.69	2.27
Significance[y]	NS	NS	NS	*	*	***	NS	NS	NS	NS	NS	***	***
Interactions[y]													
Training x spacing	NS	NS	*	*	NS	NS	NS	NS	NS	**	***	***	NS
Training x leaf removal	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Spacing x leaf removal	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Training x spacing x leaf removal	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS	NS

[z] Means separated at the 5% level by Duncan's Multiple Range Test.
[y] *,**,***,NS: Significant at $p \leq .05$, .01, or .001, or not significant, respectively.
[x] l,q: Linear or quadratic, respectively.

TOUR OF THE CAGE FOR THE ARDSA PROJECT

The tour of the cage represented the second opportunity for industry to see the 86 different grape varieties that have been collected for evaluation. This project now has entered its last stages of evaluation. The project is sponsored by the Association of British Columbia Grape Growers and is administered through its Viticulture Committee. The project is paid for 75% by the federal and provincial governments through the ARDSA program, and 25% through industry (12-1/2% by the Grape Growers Association and 12-1/2% by the major wineries; i.e. Andres, Brights, Calona, Mission Hill, Cartier).

The purpose of this project is to broaden the base of grape varieties to both grape growers and wineries. We are looking for varieties which can provide the industry with new flavours, better colour, and good wine quality, as well as being suitable for grape growing in this area. The project contains 15 varieties which are currently grown commercially in the industry. All the others are new and are unique to North America.

This whole project is unique. It is unique because the project could not have been started without the cooperation of the two levels of government, plus the grape growers and the wineries. It is unique because Plant Protection has permitted the evaluation of varieties which are not fully virus indexed. It is unique because it has a collection of the latest varieties available from Germany, Hungary and France. It is also a risky project because of the virus content in the grape material.

The project has demonstrated that irrigation and fertigation is feasible and permits the grower to control plant vigor to a large degree. This is technology that can be transferred directly to the vineyard. Innovative industry members will have the opportunity to tour the planting and to adopt fertigation, cordon training, spur pruning and management technology used in the cage. In addition, producers and wineries will be able to study the information that has been generated from this planting, and will be able to taste the wines made from varieties grown in this cage.

After 1994, we anticipate that there will be few hybrids left in the industry. We expect that varieties now in this project will play a major role in the replanting of some of these acres. We believe that the project results will be adopted quickly by the industry. Some of the varieties that are currently in the cage are already being planted,

such as the Chardonnay and the Pinot Noir clones from France. Some of the varieties not suited for the interior will be suitable for the other viticulture areas in the Fraser Valley and on Vancouver Island.

Detailed information about the varieties in both the field performance as well as the wine performance is available from the Grape Growers Association, and the project summary will be published when the project is completed. This publication may not be available until 1992.

Some of the 1990 field data and the results of the wine tasting are included with this report.

John Vielvoye

John Vielvoye, P.Ag.
Chairman, Viticulture Committee

EUROPEAN WINE GRAPE CULTIVARS IN THE HORTICULTURAL AND ENOLOGICAL PROJECT - ARDSA 11011

Code	Cultivar	Species	Code	Cultivar	Species
100	Agria	v	143	Johanisberg Riesling K21B	v
101	Auxerrois Kl. 56	v	144	K-13 (Kecskemet)	v
102	AZ64-2-254	v	145	Karat	v
103	Bianca	h	146	Kozma CSFT 55	h
104	Blauer Fruehburgunder	v	147	Kozma CSFT 194	h
105	Bl. Spatburgunder K152-86	v	148	Kozma #195	h
106	Cantaro	v	149	Kozma #525	h
107	Castor	h	150	Kozma #2423	h
108	Chardonnay (Wash.)	v	151	Kozma Pal Muscotaly	v
109	Chardonnay (Cl. 76)	v	152	Merlot	v
110	Chardonnay (Cl. 95)	v	153	Michurinetz	h
111	Chardonnay (Cl. 96)	v	154	Weissburgunder Kl. 5 GM	v
112	Chardonnay Q1342-03	v	155	NF 10-126	v
113	Ehrenfelser	v	156	Nobling	v
114	Ezerfurtue	v	157	Okanagan Riesling	h
115	Faberrebe (Cl.22/60)	v	158	Orion Kl.6 (GA 58-30)	h
116	Foch	h	159	Ortega	v
117	Fontanara	v	160	Pearl of Csaba	v
118	Gamay Beaujolais	v	161	Pearl of Zala	h
119	GF67-198-3	h	162	Perle	v
120	GF111-28-51	v	163	Phoenix (GA 49-22)	h
121	Gloria	v	164	Pinot Noir Cl. 164	v
122	GM 643-20	v	165	Pinot Noir Cl. 375	v
123	GM 646-2	v	166	Pinot Noir Q1342-01	v
124	GM 676-2	v	167	Pollux	h
125	GM 6414-11	v	168	Regner	v
126	GM 6414-26	v	169	Rieslaner Cl. 3	v
127	GM 6414-36	v	170	Rieslaner Q1335-01	v
128	GM 6421-15	v	171	Schoenburger	v
129	GM 6423-3	v	172	Silva Kl. 5 (GA 54-14)	h
130	GM 6423-12	v	173	Sirius (GA 51-27)	h
131	GM 6427-5	v	174	Suputinskyij Belyi	h
132	GM 6493-3	h	175	Muller Thurgau	v
133	GM 6495-3	h	176	We S378	v
134	GM 6497-4	h	177	Zefir (Badacscony 2)	v
135	GM 7116-26	h	178	Zengoe (Badacscony 8)	v
136	GM 7117-10	v	179	Zweigeltrebe	v
137	GM 7117-13	h	180	Eger 26	h
138	Goecseji Zamatos	h	181	Eger 30	h
139	Helfensteiner	v	182	Senator	v
140	Heroldrebe	v	183	Badacscony 10	v
141	Hoelder	v	184	GM 6417-7	v
142	Huxelrebe	v	185	Samtrot	v
			999	Cabernet Sauvignon	v

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 HARVEST - FIELD DATA - REPORT

ID#	VARIETY NAME	HARVEST DATE	TOTAL TO CRUSH	NUMBER OF PLOTS	NUMBER OF VINES	PLOT YIELD	PLOT TOTALS CLUST	--PLANT AVERAGES-- YIELD	CLUSTES QTY	CLUSTES (gms)	---LAST PRE-HARVEST SAMPLING--- #	SS	pH	TA	RATIO SS/TA
		********** Vine type = VINIFERA Fruit Colour Category = RED **********													
100	Agria	10SEP	22.6	4	12	23.41	149	1.95	12	157	4	18.8	3.47	0.63	29.8
105	Bl. Spatburgunder K152-86	24SEP	12.5	4	12	13.27	121	1.11	10	110	3	22.6	3.37	0.92	24.6
104	Blauer Fruehburgunder	03SEP	10.6	4	7	6.47	135	0.92	19	48	3	20.7	3.38	0.87	23.8
128	GM 6421-15	08OCT	57.5	4	12	55.53	274	4.63	23	203	4	18.7	3.47	0.59	31.7
129	GM 6423-3	01OCT	44.1	4	12	39.10	278	3.26	23	141	5	17.3	3.35	0.67	25.8
118	Gamay Beaujolais (Wash.)	08OCT	39.3	4	12	40.58	431	3.38	36	94	4	21.4	3.55	0.75	28.5
139	Helfensteiner	08OCT	50.0	4	12	40.62	154	3.39	13	264	3	21.8	3.44	0.70	31.1
140	Heroldrebe	08OCT	46.9	4	11	27.54	188	2.50	17	146	4	20.2	3.47	0.65	31.1
152	Merlot (Wash.)	08OCT	23.7	4	8	24.83	236	3.10	30	105	2	20.4	3.51	0.70	29.1
164	Pinot Noir Cl. 164	01OCT	6.0	4	7	6.69	58	0.96	8	115	3	22.0	3.44	0.86	25.6
165	Pinot Noir Cl. 375	17SEP	11.5	4	7	12.35	102	1.76	15	121	1	20.6	3.31	0.92	22.4
166	Pinot Noir Q1342-01	24SEP	2.9	2	3	3.10	35	1.03	12	89	2	22.9	3.46	0.76	30.1
185	Samtrot	24SEP	0.4	2	6	0.63	13	0.11	2	48	2	22.1	3.55	0.74	29.9
179	Zweigeltrebe	01OCT	26.5	4	11	28.50	151	2.59	14	189	3	18.9	3.28	0.74	25.5
		********** Vine type = VINIFERA Fruit Colour Category = WHITE **********													
102	AZ64-2-254	08OCT	22.7	4	12	23.68	163	1.97	14	145	2	18.1	3.34	0.72	25.1
101	Auxerrois Kl. 56	24SEP	26.4	4	12	27.35	317	2.28	26	86	4	20.0	3.29	0.70	28.6
183	Badacsony 10	15OCT	15.1	4	12	15.62	114	1.30	10	137	4	25.7	3.23	1.36	18.9
106	Cantaro	24SEP	16.7	4	12	17.48	171	1.46	14	102	1	21.3	3.32	0.80	26.6
109	Chardonnay (Cl. 76)	24SEP	9.6	4	12	10.62	128	0.89	11	83	1	21.5	3.39	0.88	24.4
110	Chardonnay (Cl. 95)	24SEP	14.8	4	12	16.02	151	1.34	13	106	1	21.5	3.38	0.83	25.9
111	Chardonnay (Cl. 96)	24SEP	13.5	4	12	14.45	134	1.20	11	108	1	21.3	3.41	0.74	28.8
108	Chardonnay (Wash.)	08OCT	37.1	4	12	37.96	320	3.16	27	119	3	21.3	3.42	0.80	26.6
112	Chardonnay Q1342-03	24SEP	9.6	4	12	10.48	118	0.87	10	89	1	22.1	3.40	0.79	28.0
113	Ehrenfelser	01OCT	11.6	3	6	12.54	135	2.09	23	93	2	22.4	3.25	0.82	27.3
114	Ezerfurtue	01OCT	37.9	4	12	38.87	253	3.24	21	154	1	19.7	3.40	0.72	27.4
115	Faberrebe (Cl.22/60)	24SEP	24.4	4	12	25.37	247	2.11	21	103	3	21.1	3.35	0.96	22.0
117	Fontanara	01OCT	18.5	4	12	19.94	193	1.66	16	103	1	22.7	3.39	0.80	28.4
120	GF111-28-51	27AUG	23.1	4	11	24.38	215	2.22	20	113	2	15.8	3.48	0.65	24.3
125	GM 6414-11	01OCT	10.4	4	10	11.14	91	1.11	9	122	3	22.1	3.30	0.84	26.3
126	GM 6414-26	01OCT	18.1	4	12	19.42	129	1.62	11	151	2	22.2	3.23	0.77	28.8
127	GM 6414-36	01OCT	28.7	4	12	24.90	186	2.08	16	134	3	21.1	3.26	0.79	26.7
184	GM 6417-7	08OCT	43.3	3	9	27.40	195	3.04	22	140	3	18.8	3.34	0.83	22.7
130	GM 6423-12	08OCT	59.2	4	12	53.70	301	4.48	25	178	2	21.4	3.29	0.78	27.4
131	GM 6427-5	01OCT	50.6	4	12	48.08	360	4.01	30	134	3	19.7	3.27	0.76	25.9
122	GM 643-20	24SEP	54.0	4	12	46.80	373	3.90	31	125	1	18.9	3.40	0.83	22.8
123	GM 646-2	08OCT	42.5	4	12	38.98	371	3.25	31	105	4	23.1	3.32	0.89	26.0
124	GM 676-2	08OCT	45.5	4	12	46.65	438	3.89	37	107	3	22.4	3.39	0.74	30.3
136	GM 7117-10	15OCT	31.4	4	12	21.99	232	1.83	19	95	5	20.8	3.12	1.26	16.5

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 HARVEST - FIELD DATA - REPORT

ID#	VARIETY NAME	HARVEST DATE	TOTAL TO CRUSH	NUMBER OF PLOTS	NUMBER OF VINES	PLOT TOTALS YIELD	PLOT TOTALS CLUST	--PLANT AVERAGES-- YIELD	CLUSTES QTY	CLUSTES (gms)	---LAST PRE-HARVEST SAMPLING--- #	SS	pH	TA	RATIO SS/TA
	********** Vine type = VINIFERA Fruit Colour Category = WHITE **********														
121	Gloria	17SEP	11.5	4	9	12.01	169	1.33	19	71	2	23.1	3.27	0.83	27.8
141	Hoelder	01OCT	41.2	4	12	28.74	188	2.40	16	153	2	19.3	3.30	0.83	23.3
142	Huxelrebe	17SEP	0.8	2	5	0.81	15	0.16	3	54	4	23.8	3.44	0.84	28.3
143	Johanisberg Riesling K21B	22OCT	33.0	4	12	33.53	385	2.79	32	87	4	18.3	3.06	1.16	15.8
144	K-13 (Kecskemet)	01OCT	23.8	4	12	27.79	190	2.32	16	146	1	18.2	3.26	0.82	22.2
145	Karat	24SEP	12.8	4	12	13.72	135	1.14	11	102	4	21.0	3.33	0.77	27.3
151	Kozma Pal Muscotaly	27AUG	21.1	4	12	20.81	132	1.73	11	158	2	14.6	3.43	0.62	23.5
175	Muller Thurgau	01OCT	45.3	4	11	46.47	413	4.22	38	113	2	18.5	3.28	0.77	24.0
155	MF 10-126	01OCT	14.3	4	11	14.93	212	1.36	19	70	1	22.1	3.27	0.72	30.7
156	Nobling	17SEP	4.2	4	10	4.42	51	0.44	5	87	4	23.5	3.33	1.04	22.6
159	Ortega	03SEP	25.6	4	12	26.59	328	2.22	27	81	3	18.9	3.30	0.78	24.2
160	Pearl of Csaba	27AUG	9.2	4	10	9.94	71	0.99	7	140	2	17.7	3.37	0.71	24.9
168	Regner	24SEP	23.8	4	11	24.72	141	2.25	13	175	1	21.5	3.42	0.74	29.1
169	Rieslaner Cl. 3	08OCT	34.2	4	12	27.21	253	2.27	21	108	3	23.5	3.44	0.80	29.4
170	Rieslaner Q1335-01	08OCT	22.1	3	9	22.86	204	2.54	23	112	3	22.5	3.41	0.86	26.2
182	Senator	10SEP	1.9	2	6	1.92	15	0.32	3	128	3	21.2	3.34	0.94	22.6
176	We S378	01OCT	29.1	4	12	27.99	217	2.33	18	129	1	21.1	3.23	0.85	24.8
154	Weissburgunder K1.5 GM	24SEP	27.3	4	10	28.63	291	2.86	29	98	1	18.4	3.33	0.71	25.9
177	Zefir (Badacscony 2)	03SEP	19.3	4	12	13.22	181	1.10	15	73	2	19.8	3.31	0.83	23.9
178	Zengoe (Badacscony 8)	08OCT	27.2	4	12	23.29	204	1.94	17	114	6	24.4	3.34	0.92	26.5
	********** Vine type = VINIFERA Fruit Colour Category = ROSÉ **********														
162	Perle	24SEP	11.9	4	12	12.49	157	1.04	13	80	1	19.5	3.82	0.44	44.3
171	Schoenburger	17SEP	48.0	4	12	49.77	505	4.15	42	99	1	19.5	3.49	0.62	31.5

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ID#	VARIETY NAME	HARVEST DATE	TOTAL TO CRUSH	NUMBER OF PLOTS	NUMBER OF VINES	PLOT TOTALS YIELD	PLOT TOTALS CLUST	--PLANT AVERAGES-- YIELD	CLUSTES QTY	CLUSTES (gms)	---LAST PRE-HARVEST SAMPLING--- #	SS	pH	TA	RATIO SS/TA
		********** Vine type = HYBRID						Fruit Colour Category = RED							**********
116	Foch	17SEP	34.6	4	12	35.76	1092	2.98	91	33	4	24.5	3.41	0.86	28.5
119	GF67-198-3	08OCT	31.8	4	12	32.93	334	2.74	28	99	6	19.5	3.54	0.69	28.3
149	Kozma #525	08OCT	14.7	4	12	15.45	116	1.29	10	133	2	22.2	3.42	0.86	25.8
146	Kozma CSFT 55	08OCT	33.4	4	12	34.66	435	2.89	36	80	5	24.3	3.41	0.98	24.8
153	Michurinetz	22OCT	33.4	4	12	33.74	404	2.81	34	84	4	22.1	3.17	1.17	18.9
		********** Vine type = HYBRID						Fruit Colour Category = WHITE							**********
103	Bianca	08OCT	40.8	4	12	29.62	312	2.47	26	95	3	24.5	3.50	0.81	30.2
107	Castor	08OCT	63.0	4	12	64.06	535	5.34	45	120	2	17.2	3.47	0.71	24.2
180	Eger 26	08OCT	12.1	4	12	13.25	72	1.10	6	184	2	20.4	3.32	0.87	23.4
181	Eger 30	01OCT	15.7	4	12	16.49	143	1.37	12	115	2	20.5	3.40	0.80	25.6
132	GM 6493-3	08OCT	45.4	4	12	36.80	543	3.07	45	68	3	22.6	3.32	0.74	30.5
133	GM 6495-3	08OCT	50.8	4	12	41.02	499	3.42	42	82	2	20.2	3.37	0.71	28.5
134	GM 6497-4	24SEP	39.6	4	12	31.63	305	2.64	25	104	3	20.3	3.32	0.89	22.8
135	GM 7116-26	01OCT	38.1	4	12	41.83	352	3.49	29	119	2	20.0	3.21	0.88	22.7
137	GM 7117-13	15OCT	29.3	4	12	30.01	245	2.50	20	123	3	20.0	3.11	1.20	16.7
138	Goecseji Zamatos	01OCT	27.3	4	12	28.43	239	2.37	20	119	5	20.7	3.32	0.82	25.2
148	Kozma #195	17SEP	24.2	4	11	21.91	171	1.99	16	128	3	20.3	3.35	0.94	21.6
150	Kozma #2423	10SEP	24.8	4	12	23.60	151	1.97	13	156	3	19.2	3.33	0.65	29.5
147	Kozma CSFT 194	24SEP	30.5	4	12	31.74	290	2.65	24	109	1	19.9	3.27	0.81	24.6
157	Okanagan Riesling	15OCT	42.7	4	12	43.75	646	3.65	54	68	5	19.2	3.22	0.99	19.4
158	Orion Kl.6 (GA 58-30)	08OCT	23.2	4	12	24.20	234	2.02	20	103	2	21.6	3.31	0.80	27.0
161	Pearl of Zala	01OCT	16.8	4	12	24.29	171	2.02	14	142	1	20.1	3.29	0.83	24.2
163	Phoenix (GA 49-22)	17SEP	35.8	4	11	37.22	278	3.38	25	134	4	17.0	3.32	0.68	25.0
167	Pollux	01OCT	95.8	4	12	63.52	609	5.29	51	104	1	15.3	3.35	0.64	23.9
172	Silva Kl. 5 (GA 54-14)	24SEP	38.9	4	12	39.37	269	3.28	22	146	2	16.7	3.29	0.75	22.3
173	Sirius (GA 51-27)	08OCT	34.2	4	12	35.28	351	2.94	29	101	2	18.3	3.35	0.78	23.5
174	Suputinskyij Belyi	15OCT	47.4	4	12	48.55	867	4.05	72	56	3	19.9	3.24	1.12	17.8

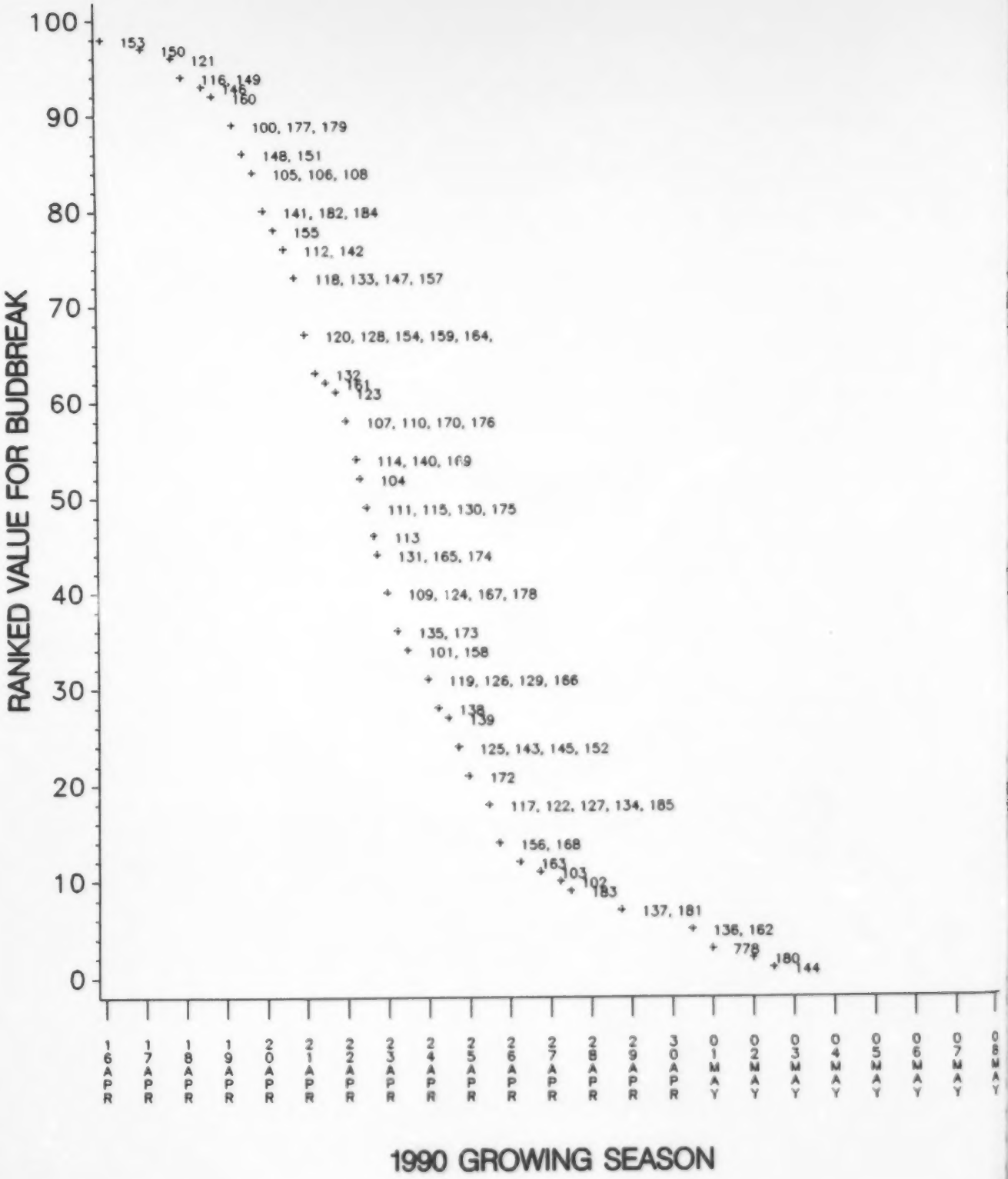
EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 HARVEST - FIELD DATA - REPORT

ID#	VARIETY NAME	HARVEST DATE	TOTAL TO CRUSH	NUMBER OF PLOTS	NUMBER OF VINES	PLOT YIELD	TOTALS CLUST	--PLANT AVERAGES-- YIELD	CLUSTES QTY	CLUSTES (gms)	---LAST #	LAST SS	PRE-HARVEST pH	PRE-HARVEST TA	SAMPLING--- RATIO SS/TA
		**********							Fruit	Colour	Category	= WHITE	**********		
778	Odd Whites(3) -R/P(14/22)	.	.	1	3	10.55	59	3.52	20	179	.	.	.	.	.

EUROPEAN GRAPE VARIETY TRIAL--ARDSA PROJECT 11011

1990 PHENOLOGY DATES--BUDBREAK



ARDSA PROJECT 11011 - 1990 - EUROPEAN GRAPE VARIETY TRIAL

FIELD SUGAR VALUES JUST PRIOR TO HARVEST

Plot of RANKED*FSS. Symbol is value of IDNO.

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 TABULAR SUMMARY OF PRUNING WEIGHTS, YIELDS AND FRUIT/WOOD RATIOS

	Winter Injury		VINES	1990 YIELD	CLUSTERS	CLUSTER WEIGHT	PLANT YIELD	CLUSTERS VINE	PRUNINGS 1990	FRUT/WOOD RATIO
	Vine Rating	Wood Die Back	TOTALS	TOTALS	TOTALS	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
IDNO										
100	3/5	<10%	12	23.41	149	154	1.95	12	261	7.4
101	1/5	<10%	12	27.35	317	83	2.28	26	249	9.4
102	3/5	<10%	12	23.68	163	141	1.97	14	149	14.9
103	2/5	20%	15	42.12	453	97	2.81	30	366	8.8
104	1/5	<10%	13	11.31	220	48	0.77	15	301	2.7
105	2/5	<10%	11	13.27	121	101	1.16	11	220	6.0
106	2/5	<10%	12	17.48	171	92	1.46	14	320	4.9
107	2/5	30%	12	64.06	535	120	5.34	45	309	18.8
108	2/5	10%	12	37.96	320	118	3.16	27	359	9.6
109	2/5	<10%	12	10.62	128	80	0.89	11	308	3.0
110	2/5	<10%	12	16.02	151	99	1.34	13	324	3.7
111	2/5	<10%	12	14.45	134	101	1.20	11	343	3.3
112	1/5	<10%	12	10.48	118	81	0.87	10	233	3.6
113	2/5	<10%	6	12.54	135	93	2.09	23	343	6.6
114	3/5	30%	12	38.87	253	155	3.24	21	241	15.7
115	3/5	10%	12	25.37	247	103	2.11	21	228	9.1
116	1/5	30%	12	35.76	1092	33	2.98	91	599	5.7
117	2/5	<10%	12	19.94	193	94	1.66	16	333	5.3
118	2/5	<10%	12	40.58	431	94	3.38	36	433	7.9
119	3/5	40%	12	32.93	334	101	2.74	28	190	17.5
120	2/5	10%	11	24.38	215	120	2.26	19	246	9.1
121	1/5	<10%	9	12.01	169	65	1.04	15	395	2.6

(CONTINUED)

Footnote: Vine ratings are made at budbreak.
0 = no damage noticed 5 = very severe damage

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 TABULAR SUMMARY OF PRUNING WEIGHTS, YIELDS AND FRUIT/WOOD RATIOS

	Winter Injury		VINES	1990 YIELD	CLUSTERS	CLUSTER WEIGHT	PLANT YIELD	CLUSTERS VINE	PRUNINGS 1990	FRUT/WOOD RATIO
	Vine Rating	Wood Die Back	TOTALS	TOTALS	TOTALS	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
IDNO										
122	3/5	10%	15	55.78	431	129	3.72	29	364	11.7
123	2/5	<10%	15	43.57	425	101	2.90	28	359	8.4
124	2/5	10%	12	46.65	438	107	3.89	37	391	10.4
125	1/5	<10%	10	11.14	91	122	0.93	8	460	2.7
126	1/5	<10%	12	19.42	129	153	1.62	11	258	7.4
127	2/5	10%	15	29.66	235	129	1.98	16	331	6.5
128	1/5	10%	15	59.36	298	203	3.96	20	334	12.2
129	2/5	10%	15	46.30	341	140	3.09	23	330	10.2
130	2/5	<10%	15	60.99	345	176	4.07	23	317	14.4
131	2/5	<10%	15	52.01	399	129	3.47	27	308	12.7
132	1/5	<10%	15	46.83	655	72	3.12	44	376	8.9
133	1/5	<10%	15	52.24	647	82	3.48	43	711	5.2
134	2/5	10%	15	42.74	395	108	2.85	26	307	9.7
135	1/5	<10%	12	41.83	352	118	3.49	29	323	11.7
136	3/5	20%	15	32.34	337	98	2.16	22	249	9.4
137	3/5	10%	12	30.01	245	125	2.50	20	170	15.0
138	3/5	20%	12	28.43	239	117	2.37	20	183	13.9
139	2/5	<10%	17	52.06	195	275	3.03	11	328	9.8
140	2/5	<10%	16	48.97	312	159	2.99	19	354	9.6
141	2/5	10%	15	42.92	283	150	2.86	19	310	10.3
142	5/5	10%	5	0.81	15	55	0.17	3	159	1.1
143	2/5	<10%	12	33.53	385	87	2.79	32	239	12.2

(CONTINUED)

Footnote: Vine ratings are made at budbreak.
0 = no damage noticed 5 = very severe damage

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 TABULAR SUMMARY OF PRUNING WEIGHTS, YIELDS AND FRUIT/WOOD RATIOS

	Winter Injury		VINES	1990 YIELD	CLUSTERS	CLUSTER WEIGHT	PLANT YIELD	CLUSTERS VINE	PRUNINGS 1990	FRUT/WOOD RATIO
	Vine Rating	Wood Die Back	TOTALS	TOTALS	TOTALS	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
IDNO										
144	5/5	<10%	12	27.79	190	143	2.32	16	262	10.2
145	3/5	<10%	12	13.72	135	97	1.14	11	256	4.9
146	2/5	10%	12	34.66	435	80	2.89	36	389	9.4
147	3/5	30%	12	31.74	290	111	2.65	24	176	17.3
148	1/5	<10%	11	21.91	171	125	1.93	15	298	6.7
149	2/5	<10%	12	15.45	116	99	1.29	10	340	3.8
150	2/5	10%	14	25.74	167	148	1.79	12	335	6.8
151	3/5	<10%	15	23.03	152	139	1.54	10	299	5.2
152	2/5	10%	8	24.83	236	105	3.35	33	560	5.6
153	1/5	10%	12	33.74	404	85	2.81	34	337	8.3
154	1/5	10%	10	28.63	291	98	2.99	30	259	11.7
155	2/5	<10%	11	14.93	212	66	1.27	18	243	5.4
156	4/5	20%	10	4.42	51	78	0.43	5	161	2.5
157	3/5	50%	12	43.75	646	68	3.65	54	475	8.5
158	1/5	10%	12	24.20	234	99	2.02	20	218	10.0
159	1/5	10%	12	26.59	328	81	2.22	27	376	5.8
160	1/5	10%	10	9.94	71	116	0.84	6	192	4.4
161	3/5	30%	12	24.29	171	155	2.02	14	194	13.5
162	2/5	10%	12	12.49	157	79	1.04	13	217	5.5
163	3/5	10%	11	37.22	278	134	3.27	24	259	15.1
164	2/5	10%	4	6.69	58	94	1.30	13	197	6.6
165	2/5	10%	8	12.35	102	110	1.53	13	149	9.0

(CONTINUED)

Footnote: Vine ratings are made at budbreak.
0 = no damage noticed 5 = very severe damage

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990 TABULAR SUMMARY OF PRUNING WEIGHTS, YIELDS AND FRUIT/WOOD RATIOS

	Winter Injury		VINES	1990 YIELD	CLUSTERS	CLUSTER WEIGHT	PLANT YIELD	CLUSTERS VINE	PRUNINGS 1990	FRUT/WOOD RATIO
	Vine Rating	Wood Die Back	TOTALS	TOTALS	TOTALS	AVERAGE	AVERAGE	AVERAGE	AVERAGE	AVERAGE
IDNO										
166	2/5	10%	3	3.10	35	89	1.03	12	173	5.5
167	2/5	50%	18	101.03	945	109	5.61	53	317	19.0
168	4/5	10%	11	24.72	141	173	2.22	13	223	9.8
169	1/5	10%	15	35.64	329	108	2.38	22	551	6.2
170	1/5	<10%	9	22.86	204	115	2.54	23	338	8.4
171	2/5	10%	12	49.77	505	99	4.15	42	382	12.5
172	2/5	10%	12	39.37	269	150	3.28	22	267	14.3
173	2/5	20%	12	35.28	351	104	2.94	29	198	17.3
174	1/5	40%	12	48.55	867	56	4.05	72	655	6.6
175	3/5	<10%	11	46.47	413	113	4.37	39	344	13.2
176	4/5	<10%	15	33.83	266	120	2.26	18	250	9.4
177	4/5	<10%	15	19.93	258	72	1.33	17	441	2.8
178	4/5	10%	15	28.45	257	109	1.90	17	320	6.8
179	3/5	<10%	11	28.50	151	196	2.74	14	195	16.0
180	2/5	10%	12	13.25	72	182	1.10	6	123	10.6
181	2/5	10%	12	16.49	143	115	1.37	12	180	7.7
182	5/5	20%	6	1.92	15	127	0.32	3	92	4.3
183	5/5	<10%	12	15.62	114	149	1.30	10	199	8.6
184	2/5	10%	12	44.84	301	145	3.74	25	394	9.8
185	1/5	20%	6	0.63	13	37	0.11	2	206	0.4
778	2/5	<10%	3	10.55	59	179	3.52	20	410	8.8

Footnote: Vine ratings are made at budbreak.
0 = no damage noticed 5 = very severe damage

WINE EVALUATION OF GERMAN, HUNGARIAN AND FRENCH GRAPE VARIETIES IN THE ARDSA PROJECT

Five winemakers were presented with wines made from 65 white and 18 red grape varieties in the ARDSA project for evaluation on July 10, 1991. They tasted the wines according to the VQA format and scored them for defects,flavor intensity of aroma, intensity of taste, commercial potential and gave comments about the wines.

All wines were well made. Five of the red (Pinot Noir types) had some bacterial spoilage and were not evaluated. These were Gamay Beaujolais, Pinot noir clone 164, Pinot noir clone 375, Blauer Spatburgunder clone 152-86, Blauer Fruehburgunder One variety, Foch, although selected in the blind tasting as being among the top choice in the reds, is felt not to have future commercial potential. In addition to the wines affected by bacterial spoilage and Foch as a standard,Forty two other varieties were selected as worthy of further evaluation and detailed description. They were as follows:

Most preferred

White Varieties	Intensity Aroma	Taste	Body	Commercial Potential
Score System	0-3	0-3	0-3	0-5
Maximum Score	15	15	15	25
Auxerrois cl. 56	10.5	9.5	9.5	12.5
Cantaro	9	10	11	12.5
Chardonnay c. 96	6	7	8	9
Chardonnay cl. 76	6	7.5	7.5	10
Gloria	9.5	11	10	11.5
GM 676-2	10	10	9	14
GM 6417-7	10	9	11	16
GM 6427-5	10.5	11	10	12.5
Hoelder	10	12	8	14
Muller Thurgau	10.5	11	12	14.5
Ortega	11	11	8.5	13
Pearl of Csaba	9.5	11	10	11.5
Zefir	15.5	12	7	16

Most preferred

Red Varieties	Intensity Aroma	Taste	Body	Commercial Potential/color	
Score System	0-3	0-3	0-3	0-5	0-3
Maximum Score	15	15	15	25	15
Cab, Sauvignon	9.5	9.5	8.5	13	10.5
Kozma # 55	11	11.5	11.5	15	14
Merlot	8.5	9	8	12	12.5

Other varieties felt worthy of further evaluation were as follows:

All 5 of the Pinot noir types mentioned as having bacterial spoilage since that was not a fault of the variety plus the clones of Pinot noir not yet in production (Pinot noir Q1342-01, Senator, and Samtrot)

All 5 of the Chardonnay selections in the program because clonal evaluations of these selections may indicate differences amongst them (Clone 76, 95, 96, Q1342-03, Washington)

The following varieties were felt by 1 or more wine makers to have some characteristics that justified keeping it in the project for further evaluation.

White Varieties	Intensity Aroma	Taste	Body	Commercial Potential
Score System	0-3	0-3	0-3	0-5
Maximum Score	15	15	15	25
Castor	11	10	8	8
Ezerfurtu	8.5	8.5	8.5	13
Faberrebe (Cl. 22/60)	12.5	10.5	10	14.5
GM 6414-11	4	5	7	9
GM 6414-36	7.5	8.5	8.5	8
GM 6495-3	3	5.5	3	10.5
GM 7117-10	12	10	11	15.5
k-13	11.5	10.5	7.5	12.5
Schonburger	10	10	9	10

Weissburgunder	6	7	8	9
Red Varieties	**Intensity Aroma**	**Taste**	**Body**	**Commercial Potential/color**
Score System	0-3	0-3	0-3	0-5 0-3
Maximum Score	15	15	15	25 15
Agria	9.5	10	8	12.5 13.5
GM 6421-15	5.5	9	5.5	12 6
Helfensteiner	9.5	10	10	13 8.5
Heroldrebe	8.5	10	9	13.5 7.5
Zweigeltrebe	8	9.5	9.5	11.5 7.5

Other varieties in the project were scored as follows

White Varieties	**Intensity Aroma**	**Taste**	**Body**	**Commercial Potential**
Score System	0-3	0-3	0-3	0-5
Maximum Score	15	15	15	25
AZ 64-2-254	8	7	6.5	8
Badacsony 10	6	8.5	8	7.5
Bianca	7	9	9	6
Eger 26	6	7	7	6
Eger 30	9	9	10	9
Ehrenfelser	7.5	6.6	9	8
Fontanara	10	11	8	13
GF 111-28-51	8	9	7.5	7
GM 643-20	5.5	6.5	6.5	8.5
GM 646-2	7.5	10	10	11.5
GM 6414-26	4	6	5	7.5
GM 6423-12	7.5	8.7	7	10
GM 6493-3	10	10	9	14
GM 6497-4	10	9.5	9.5	8.5
GM 7116-26	8.5	6.5	7.5	10.5
GM 7117-13	6	9	9	10
Goecseji Zamatos	11	6.5	6	9.5
Johanisberg Riesling clone 21 B	6	6	5	3.5
Karát	5.5	6.5	10	9
Kozma # 194	5	5.5	7.5	9
Kozma # 195	8.5	9	10	8.5

Kozma # 2423	6	7	8	5
Kozma Pal, Muscotaly	7.5	7.5	5.5	4.5

White Varieties	Intensity Aroma	Taste	Body	Commercial Potential
Score System	0-3	0-3	0-3	0-5
Maximum Score	15	15	15	25
NF 10-126	14.5	11	9	7.5
Okanagan Riesling	8	9.5	6	2
Orion (cl. 6 GA 58-30)	6.5	8	9.5	6
Pearl of Zala	6.5	7.5	7.5	9
Perle	6.5	9.5	10	11.5
Phoenix (GA 49-22)	8	7	8	8.5
Pollux	6.5	7.5	8	12
Regner	9	11	10	11.5
Rieslaner cl. 3	8	9	11	12
Rieslaner Q 1335-01	9.5	10.5	11.5	11.5
Silva (cl. 5. GA 54-14)	9	7	8	8
Sirius (GA 51-27)	5.5	8.5	8.5	9
Suputinskyij Belyi	7.5	6	5.5	5
WE S 378	7	7.5	7.5	9
Zengoe	7	8	10	5

Red Varieties	Intensity Aroma	Taste	Body	Commercial Potential	/color
Score System	0-3	0-3	0-3	0-5	0-3
Maximum Score	15	15	15	25	15
Foch	12.5	10.5	12	16.5	15
GF 67-198-3	7.5	9.5	9	16	15
GM 6423-3	8	9	7	7	6
Kozma # 525	7.5	9.5	9	16	15
Michurinetz	8.5	10	10	11.5	15

ADDITIONAL COMMENTS MADE ABOUT THE VARIETIES IN THIS TASTING

White Variety	Defects	Flavor/Comment
Auxerrois	cork/acidic	apple/tart/light some fruit/
AZ 64-2-254	acidic/no	bland/bitter/fruity/tart Riesling acid/
Badacsony 10	no/acidic	chemical/tart/sweaty cardboard/neutral/crisp
Bianca	no	neutral/melon/peach candy/hybrid/sweet nice fruity taste
Cantaro	no/acidic	neutral/soft/apple sl.tropical/tart/delicate lots of flexability interesting/bulk
Castor	acidic	strong melon/hybrid pineapple/low ta muscat/fruity/
Chardonnay (cl. 76)	nose	papya/peach/ripe fruit
Chardonnay (cl. 95)	no	riesling/apple/muscat
Chardonnay (cl. 96)	nose	cardboard/neutral
Chardonnay (Q1342-03)	acidic/nose	sweaty/vegetal/sl.tropical
Chardonnay (Wash)	nose	odd/resin/neutral
Eger 26	no	tannic/astringent/tart interesting Gewurtz-like aroma/vegetal/unpleasant
Eger 30	oxidized/no	neutral/ballanced/ surface yeast/unpleasant
Ehrenfelser	no	friut/apple/blender/ neutral/very different
Ezerfurtue	no	hybrid/honey/spice/earthy interesting aroma/crisp sl.bitter/short finish potentail for cellar treat.
Faberrebe (cl.22/60)	oxidized/no	earthy/apple/crisp french style/fruit fruity /not complex
Fontanara	no	neutral/earthy/rubber nose

		hybrid/delicate/sl.perfumy
		well ballanced/soft
GF 67-198-3	nose/no	confused candy-like/thin
		baked apple/french style
		possible/unpleasant
Gloria	no	mellow/soft/low TA/crisp
		french style/earthy/vegetal
		interesting/flower nose
		useful/French style
GM 643-20	no/acidic	ballanced/coul be
		interesting/thin
GM 646-2	nose/acidic	sl.veggy/tart/neutral
		muscat/apple/hybrid
		wet straw/unpleasant
GM 676-2	no/acidic	bitter/sl.veggi/clean
		good blender/pleasant
		crisp/good color/French
GM 6414-11	no	neutral/apple/high sugar
		very different
GM 6414-26	not clean	neutral/blender/crisp
		thin/sl.cabbage/acid/clean
		nothing special
GM 6414-36	acidic/no	tart but interesting/
		almost hybrid nose/candy
		French style/
GM 6417-7	no	tart finish/muscat/nice
		pleasant/soft/floral/citrus
GM 6423-12	no/acidic	grass/varietal/sharp/tart
		chemical/neutral/
		unpleasant/good ballance
GM 6427-5	no/acidic	tart/berry-like/neutral
		chardonnay/vegetal/crisp
		potential for barrels/clear
		not too intense/body good
GM 6493-3	so2/no	fresh fruit/useful/cherries
		balanced/clean/light/tart
		fruit nose/red wine flavor
GM 6495-3	no/acidic	neutral/melon/toasty/
		neutral/good ballance
GM 6497-4	no/acidic	sl.asparagus/peas/vegy
		neutral/yeast note/earthy
		vanilla/candy/thin/musty
GM 7116-26	acidic/no/other	tart/berry-like/neutral

		not unpleasant but yeasty
GM 7117-10	out of ballance acidic	veg. taste/sl.greenpepper has potential/sl.muscat/ vegetal/floral/riesling-like
GM 7117-13	no/acidic	spicy/muscat/floral/ deep color/tart/Germanic Riesling character early maturing/Bacchus
Goecseji Zamatos	no	muscat/limited/floorwax bitter/oxidized/tart/bland
Hoelder	no	plastic/ sl.muscat/vanilla/fruit sl.bitter/good acid/ varietal/posabilities
K-13	no	Germanic style/good nose sharp/fruity/sl.citrus muscat/sl.bland/fresh
Karat	no	neutral/good after taste acidic/sl.vegetal/earthy blender/tart/french style
Kozma # 194	no	chemical taste asparagus/melon/thin riesling/vegetal
Kozma # 195	acidic/no	potential French style sharp/vegy/light/sl.peach
Kozma # 2423	nose/no	nice TA/muscat/biting acid high/green pepper sharp/weedy/resin note
Kozma Pal, Muscotaly	nose/no	thin /no good/odd nose intense fragrant nose
Muller Thurgau	acidic/no	no depth/musty/odd nose muscat/medicinal/berry Riesling-like/raspberry
NF 10-126	no	nose excellent hot/high acid/stemmy resin nose/oxidized?/yeast
Okanagan Riesling	no	phenolic/good after taste alfalfa/strange/barn hay soapy/bubble gum/harsh tart/muscat/intense candy

Orion (cl.6 GA 58-30)	no	optima flavor/berries sweet/not pleasant/grapy
Ortega	no	interesting varietal/muscat melon/blender/ballanced fresh flowery nose/light chemical/hot/vegetal
Pearl of Csaba	no	limited appeal/like Bacchus very fruity/flowers/muscat cardboard/thin/sharp
Pearl of Zala	nose	hybrid/medicinal/acidic crisp/nice ballance
Perle	other/no	residual sugar makes it o.k. fruity/pineapple/kerosine sl.metalic/light/bitter musty aftertaste/strange better dry/pleasant
Phoenix) (GA 49-22)	no	vegetal/earthy/flinty thin/blender/ballanced
Pollux	no/acidic	peach/melon/hybrid thin/Riesling direction not interesting
Regner	acidic	riesling-like/tart/melony crisp/fruity/spice/bulk
Rieslaner cl. 3	no	nice wine/sl.sweet/bitter scotch/oxidized/yeasty/
Rieslaner (Q1335-01)	no	tart/beer-like/thin/light sl.almond/vegy/sweaty
Riesling cl. 21 B	no/acidic	ripe/mature/thin/tart cardboard/berry
Schonberger	nose/no	interesting/fruit/spicy fresh light fruit/sweet diesel/h2s/
Silva	no/acidic	hybrid/skunky/chemical
Serius	no/acidic	neutral/hybrid nose
Suputinskyij Belyi	nose	barnyard/wet straw/sweet unpleasant/musty/fruity citrus acid/
WE 378	acidic/so2	Riesling type acid/crisp winesap apple/neutral tart/french style/astringent

Weissburgunder (cl. 5 GM)	acidic/no	neutral/blender/ballanced pleasant acid/hybrid/vegy
Zenfir	no	limited amounts/thin acid intense fruit/sharp/fresh sl.bitter/extreme muscat
Zengoe	oxidized/ tannic	sl.tannic/stealy/bitter harsh/astringent sherry base

Red Variety	**Defects**	**Flavor/Comment**
Agria	no/ethyl	excellent character tannic/cedary/hybrid? fruity muscat/blender raisin aftertaste
Blauer Fruehburgunder	plastic/VA ethyl/acetate bacteria	unpleasant nose/ vegetal/bitter
Blauer Spatburgunder	nose/no bacteria	fruit/raspberry/tannic reasonable acid/tart
Cabernet Sauvignon	sl.h2s/no	clover/good tannin high acid/raspberry/spice
Foch	acidic	very dark/good ballance soft/good blender/smoke sl.grapy/greenbean/eathy interesting/strange/spicy
Gamay Beaujolais	bacteria	young/hybrid/wet fur nose no tannin/lots of acid/light
GF 67-198-3	no/h2s	coloring/hybrid nose &taste stemmy/neutral/
GM 6421-15	no	musty/ballanced/useful neutral/tart/cork?/pepper too light/acidic/tannic
GM 6423-3	mouse/ acidic	off nose/gooseberry taste bitter/thin/candy nose neutral/no future
Helfensteiner	no	good tannin/sl.must/tannic no fruit/typical red wine clean but acidic
Heroldrebe	no	high tannin/pleasant/acid earthy/vegital/blender
Kozma # 525	no	nose little off/spicy/thin neutral/tart/caramel

		peppery/intense color no future
Kozma #55	no/h2s	sharp acid/nice nose stemmy/sl.hybrid/spicy fruit/berries/tart
Merlot	no	clover nose/straw taste good tannin and acid/ some veggy&spice/good
Michurinetz	no	straw nose/acetone/hot acid/tannin/metallic raisin/astringent/cherries no future
Pinot noir cl. 164	bacteria	lots of tannin & fruit
Pinot noir cl. 375	bacteria	good tannin/sl.minty/ML ?
Zweigeltrebe	out of ballance/no	tart/pleasant/tannic light/earthy/neutral

IRRIGATION RESPONSES IN A COOL CLIMATE

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ABSTRACT

Increases in fruit yield and juice quality were measured when Muller Thurgau grapes were irrigated using trickle irrigation. Responses varied between seasons, and sites, with greatest increases occurring in dry years, particularly where the volume of water available to the plant was low. The volume of water available to the vines was influenced by soil type, vine age and irrigation, with root development of irrigated vines (as measured by water extraction patterns) being closer to the soil surface.

INTRODUCTION

Water is essential for plant growth. During summer months, a lack of soil water is frequently the most important factor limiting crop growth and yields. To minimise soil water deficits, and maximise yields, irrigation is frequently used to supplement irregular and inadequate rainfall. Irrigation of grapes is now widely practiced in many parts of the world and is considered essential in more arid regions. A recent survey estimated that approximately 40,000 ha of grapes are trickle irrigated throughout the world (Abbott 1984).

Despite the potential yield advantages associated with irrigation, irrigating wine grapes has traditionally been viewed with caution. The possibility that irrigation may have a deleterious effect on wine quality means that the practice is largely forbidden in the Appelation d'Origine Controllee (AOC) regions of France. Some of these effects may be considered as a direct effect on the changes in water status, while others as a result of indirect effects e.g., increased shading following enhanced vegetative growth. These aspects were well reviewed by Smart and Coombe (1983).

The response of grapes to irrigation will largely depend on soil water availability and climate. In temperate growing regions, rainfall will often provide significant amounts of water to vines during the season. Whether this needs to be supplemented by irrigation will depend on the frequency and amount of rain, the rate of loss of water from the vineyard by evaporation, transpiration and drainage, and the size of the soil water storage volume available to the plant in the soil.

Soil texture has a significant affect on water storage within the soil profile. Water storage may range from 30 mm m^{-1} in sandy or stony soils, to in excess of 150 mm m in silt-loam soils, per metre of soil profile. The ability of plants to exploit that water volume largely depends on the distribution of roots in the profile, and their absorptive activity (Richards, 1983). The distribution can be affected by a number of factors including:

1. Competition between crop roots and other plants (Atkinson and Wilson, 1980);

2. Differences between plant species, cultivars (Perry et al., 1983) and root stocks (Rogers and Vyvyan, 1934);

3. Localised placement of nutrients (Drew, 1975) and/or water (Safran et al., 1975).

As plants transpire, and the soil dries out, a critical soil moisture deficit is reached. From this point it becomes increasingly difficult for plants to extract the remaining water in the profile. To conserve water stomatal closure occurs resulting in a decrease in transpiration and photosynthesis. Yield and quality losses can then be anticipated. To minimise these losses, water needs to be added to the system, either as rainfall, or by irrigation.

While water is important, to fully express a response to irrigation, other crop management factors need to be in balance. Vines grow in equilibrium with their environment and changing one factor has an influence on others. For example irrigation may result in enhanced vegetative growth, and the associated shading may result in decreased wine quality (Smart and Coombe, 1983). Thus the management practices (pruning, training crop, load etc.) of irrigated and non-irrigated vines are likely to differ.

Marlborough is a new, rapidly expanding area of wine production in New Zealand. The first commercial vineyards were planted in the early 1970's, and the total area in production has now reached in excess of 500 ha. The region has a temperature climate with an average rainfall of 650 mm which is on average, well distributed through the year. Potential evaporation (Class A Pan) during the growing season (October to March) is in excess of 1,000 mm. This makes the region susceptible to summer drought in some seasons. Vineyards are a significant user of irrigation water on the Wairau Plains. Trials were started in 1979 to evaluate the response of grape vines to irrigation.

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990/91 WINTER INJURY - VISUALLY ASSESSED PERCENTAGE OF DAMAGED WOOD ON THE VINE

Analysis Variable : PCNTCODE

IDNO	N Obs	Mean
100	12	1
101	12	1
102	12	1
103	15	3
104	13	1
105	11	1
106	12	1
107	12	4
108	12	2
109	12	1
110	12	1
111	12	1
112	12	1
113	6	1
114	12	4
115	12	2
116	12	4
117	12	1
118	12	1
119	12	5
120	11	2
121	9	1
122	15	2
123	15	1
124	12	2
125	10	1
126	12	1
127	15	2
128	15	2
129	15	2
130	15	1
131	15	1
132	15	1
133	15	1
134	15	2
135	12	1
136	15	3
137	12	2
138	12	3
139	17	1
140	17	1
141	15	2
142	5	2
143	12	1
144	12	1
145	12	1
146	12	2
147	12	4
148	11	1
149	12	1

EUROPEAN GRAPE VARIETY TRIAL - ARDSA PROJECT 11011

1990/91 WINTER INJURY - VISUALLY ASSESSED PERCENTAGE OF DAMAGED WOOD ON THE VINE

Analysis Variable : PCNTCODE

IDNO	N Obs	Mean
150	14	2
151	15	1
152	8	2
153	12	2
154	10	2
155	11	1
156	10	3
157	12	6
158	12	2
159	12	2
160	10	2
161	12	4
162	12	2
163	11	2
164	4	2
165	8	2
166	3	2
167	18	6
168	11	2
169	15	2
170	9	1
171	12	2
172	12	2
173	12	3
174	12	5

IDNO	N Obs	Mean
175	11	1
176	15	1
177	15	1
178	15	2
179	11	1
180	12	2
181	12	2
182	6	3
183	12	1
184	12	2
185	6	3
778	3	1

METHODS

Two trials are described in this paper. In both cases Muller Thurgau grapes growing were trickle irrigated. The vineyards, owned by Montana Ltd, are located on the Wairau Plains west of Blenheim. Soils of the Plains belong to recent alluvial series, variable with many old river channels. This results in sudden changes in textural classes over short distances and at different levels down the profile.

The first trial site is located on the Brancott vineyard. The soil type belongs to the Fairhall series. This is a recent alluvium with an average 300 mm topsoil. This topsoil overlies a yellow-brown silt loam to a depth of 1 to 2 metres. The profile has an available water content of about 170 mm to a depth of 1 metre. At the interface of the topsoil and sub-soil is a hard yellow fragipan.

Daily irrigation was started in October and supplied the equivalent of 12.5 mm per week to the vineyard area, irrespective of the evapotranspiration. Water was applied from the start of the season for different durations (to two weeks after flowering, bunch closure, veraison, and harvest) except during periods of heavy rainfall (>5 times E.T.), when irrigation was stopped for five days. The trial was established in 1980, and irrigation treatments started in the 1980-81 season. The vines were then six years old and were previously unirrigated. In the 1985-86 season, new treatments were super-imposed. Some of the vines previously irrigated to harvest had irrigation stopped and previously unirrigated vines were irrigated to harvest. At the same time neutron probe access tubes were installed, and regular measurements of soil water content made. The manufacturers calibration is used in the results presented here.

The second trial is located on the Renwick vineyard and was established in 1983, when the vines were eight years old. Two sites were used. The first belongs to the Omaka series with an available water content of 155 mm to a depth of 1 metre. The second site is located on a stony ridge, approximately 400 metres from the first site having a much lower available water content, 56 mm to 1 metre.

Water was supplied at different rates throughout the season, representing 0.16, 0.32, 0.49 and 0.65 of Class A pan evaporation.

RESULTS

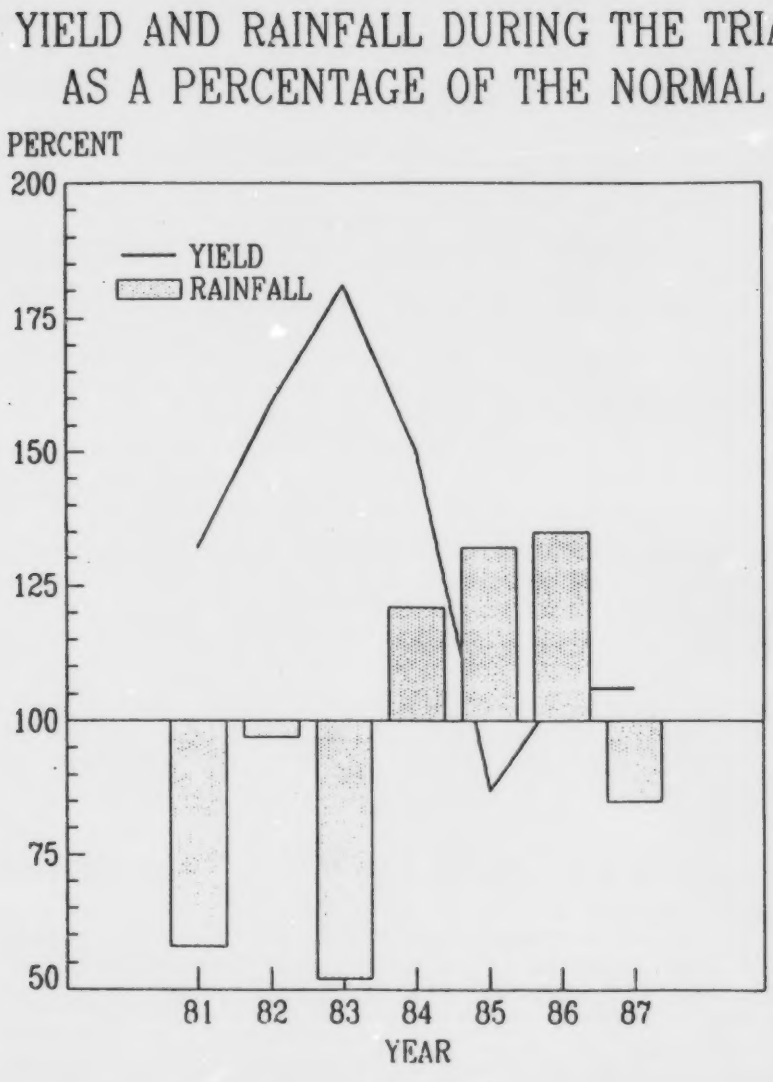
First Trial

During the course of the experiments, rainfall has been quite variable. In the first three seasons (harvested in 1981 to 1983), rainfall was less than average (Figure 1), leading to a significant potential deficit developing. However, in 1984 to 86, rainfall was between 25 and 40% above average. In 1987, rainfall was low in the mid-season, however was above average for the three to four weeks prior to harvest.

EUROPEAN WINE GRAPE CULTIVARS IN THE HORTICULTURAL AND ENOLOGICAL PROJECT - ARDSA 11011

Code	Cultivar	Species
100	Agria	v
101	Auxerrois Kl. 56	v
102	AZ64-2-254	v
103	Bianca	h
104	Blauer Fruehburgunder	v
105	Bl. Spatburgunder K152-86	v
106	Cantaro	v
107	Castor	h
108	Chardonnay (Wash.)	v
109	Chardonnay (Cl. 76)	v
110	Chardonnay (Cl. 95)	v
111	Chardonnay (Cl. 96)	v
112	Chardonnay Q1342-03	v
113	Ehrenfelser	v
114	Ezerfurtue	v
115	Faberrebe (Cl.22/60)	v
116	Foch	h
117	Fontanara	v
118	Gamay Beaujolais	v
119	GF67-198-3	h
120	GF111-28-51	v
121	Gloria	v
122	GM 643-20	v
123	GM 646-2	v
124	GM 676-2	v
125	GM 6414-11	v
126	GM 6414-26	v
127	GM 6414-36	v
128	GM 6421-15	v
129	GM 6423-3	v
130	GM 6423-12	v
131	GM 6427-5	v
132	GM 6493-3	h
133	GM 6495-3	h
134	GM 6497-4	h
135	GM 7116-26	h
136	GM 7117-10	v
137	GM 7117-13	h
138	Goecseji Zamatos	h
139	Helfensteiner	v
140	Heroldrebe	v
141	Hoelder	v
142	Huxelrebe	v
143	Johanisberg Riesling K21B	v
144	K-13 (Kecskemet)	v
145	Karat	v
146	Kozma CSPT 55	h
147	Kozma CSPT 194	h
148	Kozma #195	h
149	Kozma #525	h
150	Kozma #2423	h
151	Kozma Pal Muscotaly	v
152	Merlot	v
153	Michurinetz	h
154	Muller Thurgau	v
155	NF 10-126	v
156	Nobling	v
157	Okanagan Riesling	h
158	Orion Kl.6 (GA 58-30)	h
159	Ortego	v
160	Pearl of Csaba	v
161	Pearl of Zala	h
162	Perle	v
163	Phoenix (GA 49-22)	h
164	Pinot Noir Cl. 164	v
165	Pinot Noir Cl. 375	v
166	Pinot Noir Q1342-01	v
167	Pollux	h
168	Regner	v
169	Rieslaner Cl. 3	v
170	Rieslaner Q1335-01	v
171	Schoenburger	v
172	Silva Kl. 5 (GA 54-14)	h
173	Sirius (GA 51-27)	h
174	Suputinskyij Belyi	h
175	Weissburgunder Kl. 5 GM	v
176	We S378	v
177	Zefir (Badacscony 2)	v
178	Zengoe (Badacscony 8)	v
179	Zweigeltrebe	v
180	Eger 26	h
181	Eger 30	h
182	Senator	v
183	Badacscony 10	v
184	GM 6417-7	v
185	Samtrot	v

FIGURE 1



Irrigation to harvest (trt 5) (note: treatment numbers refer to those given in Table 1) increased grape yields by 24%, when compared to the unirrigated control treatment (trt 1). Most of this response to irrigation occurred in the first four years of the trial (Figure 1, Table 1), with no significant response between 1985 and 1987. The majority of the yield response in the early years of the trial was a reflection of irrigation in the later parts of the season (Table 1). By the 1984/85 season, there were no differences in yield between irrigated (trts 2-5) and the non-irrigated treatment (1).

Irrigating previously dry plots in the 1985/86 and 1986/87 seasons caused a small increase in yield over the continuously dry treatment, but was no different to irrigation throughout. However, discontinuing irrigation (trt 7) caused a significant decrease in yield in the drier 1987 season when compared to the continuously dry treatment (trt 1).

TABLE 1

INFLUENCE OF IRRIGATION ON GRAPE YIELD

	TREATMENT	YIELD T HA^{-1} 1980/81	1982/83	1985/86	1986/87
1	DRY	10.0 a	8.8 a	16.5 a	17.1 b
	IRRIGATED TO				
2	POST FLOWERING	9.9	11.4	16.1	17.3
3	BUNCH CLOSURE	12.7	13.8	16.5	16.7
4	VERAISON	12.0	13.4	15.6	18.5
5	HARVEST	13.2 b	15.4 b	17.5 a	18.1 b
linear response to irrigation (trts 2 to 5)		**	**	NS	NS
6	DRY TO IRRIGATED	-	-	17.5 a	19.0 b
7	IRRIGATED TO DRY	-	-	16.9 a	15.3 a

NB. Statistical analyses have been done in two ways. Analysis of variance has been used to compare treatments 1, 5, 6 and 7, and values in columns with the same subscript are not significantly different ($P<0.05$). Regression analysis was used to compare the different irrigation duration (treatments 2 to 5).

Irrigation had significant effects on must quality. Over the seven years, irrigation to harvest (trt 5) has on average increased soluble solids at harvest from 16.9 to 17.9 when compared to the dry (1) treatment. In general, most of the increases in soluble solids have appeared to be as a result of early season irrigation (Table 2). Ceasing irrigation in the 1985/86 season had no effect on soluble solids in that (wet) season, but resulted in a decrease in the 1986/87 harvest, when compared to the irrigated treatments (5 and 6). Starting irrigation in the 1985/86 season, (trt 6), caused a small decrease in the soluble solids, when compared to other treatments in that season. This decrease was maintained in the 1986/87 season, when compared to the irrigated treatment (5), although soluble solids were higher when compared to the dry treatments (1 and 7).

TABLE 2

INFLUENCE OF IRRIGATION ON JUICE SOLUBLE SOLIDS

	TREATMENT	SOLUBLE SOLIDS 1980/81	1982/83	1985/86	1986/87
1	DRY	15.6 a	16.2 a	18.7 a	17.5 ab
	IRRIGATED TO				
2	POST FLOWERING	16.7	16.9	19.2	18.3
3	BUNCH CLOSURE	17.0	17.1	19.2	18.4
4	VERAISON	17.0	16.5	19.0	19.0
5	HARVEST	17.2 b	16.8 a	19.0 a	18.9 c
linear response to irrigation (trts 2 to 5)		NS	NS	NS	NS
6	DRY TO IRRIGATED	-	-	18.4 b	18.1 b
7	IRRIGATED TO DRY	-	-	18.7 a	17.2 a

Irrigation to harvest significantly ($P<0.05$) decreased the titratable acidity when compared to the dry treatment in all seasons, except 1982/83 (data for 1982, 1984 and 1985 seasons is not presented) (Table 3). Juice pH was unaffected by any of the irrigation treatments.

TABLE 3

INFLUENCE OF IRRIGATION ON JUICE TITRATABLE ACIDITY

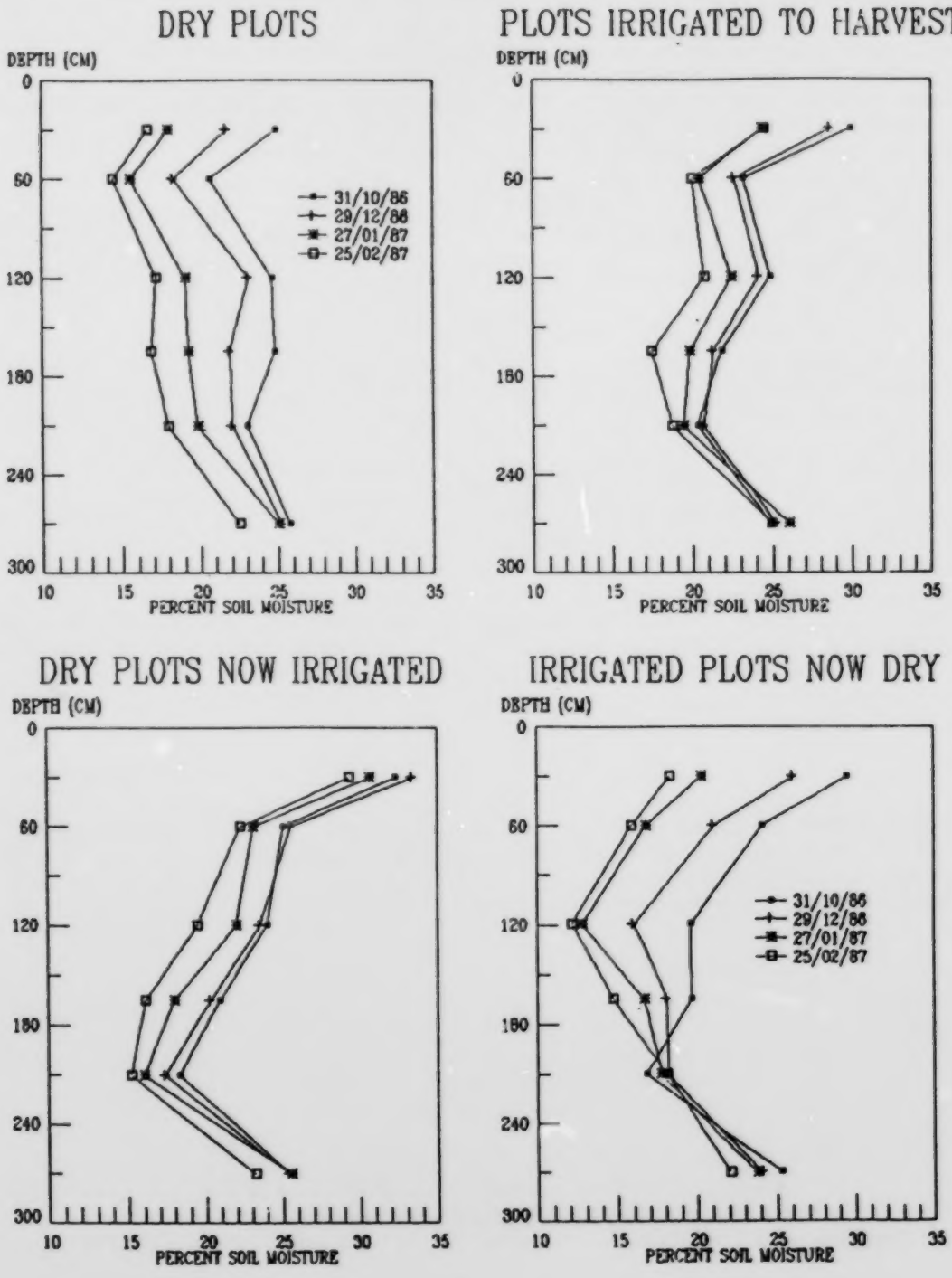
	TREATMENT	TITRATABLE ACIDITY ($g\ l^{-1}$) 1980/81	1982/83	1985/86	1986/87
1	DRY	5.88 a	7.23 a	7.77 ab	7.07 a
	IRRIGATED TO				
2	POST FLOWERING	5.99	6.90	8.22	7.13
3	BUNCH CLOSURE	6.75	6.62	8.30	7.50
4	VERAISON	7.46	6.96	8.55	7.88
5	HARVEST	7.25 b	6.84 a	8.60 c	8.19 b
linear response to irrigation (trts 2 to 5)		**	NS	NS	**
6	DRY TO IRRIGATED	-	-	8.27 bc	7.92 b
7	IRRIGATED TO DRY	-	-	7.28 a	6.77 a

WATER EXTRACTION

A fragipan at 30 cm appeared to limit root development to the surface horizons during the vines establishment years. However, by 1985, water extraction patterns indicated that vine roots had penetrated the pan, and were extracting water from 2.7 metres in the profile, and probably at greater depths.

Changes in soil water content of four of the treatments in the 1986/87 season are shown in Figure 2. Where vines had ben irrigated, the changes in soil water content were small when compared to the unirrigated plots. Changes in soil water content at depths greater than 180 cm appears to be a reflection of the irrigation history up to 1985. Where plots had not been irrigated to 1985, changes in soil water content were similar throughout the profile. However, there was a marked decrease in extraction at depth, where vines had a history of irrigation. When vines were transferred from an irrigation regime to dry in 1985, water extraction was largely limited to the surface horizons, suggesting that this is where the majority of root development had occurred.

Figure 2

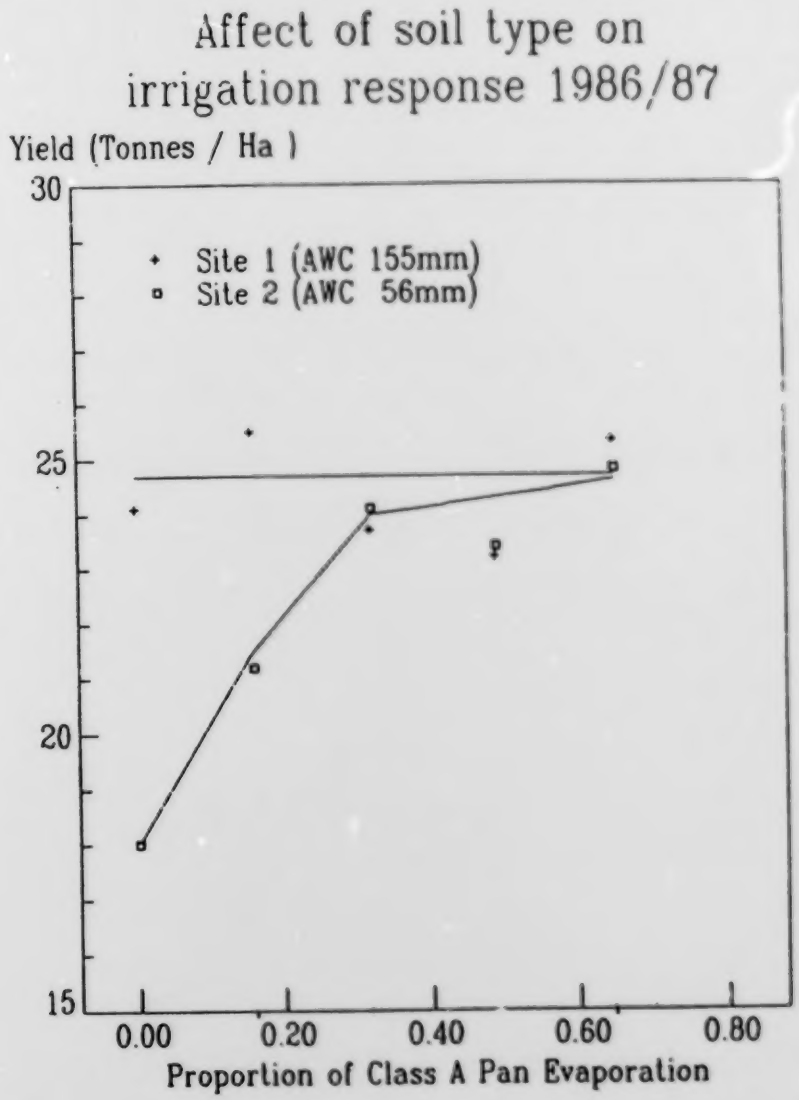

DRY PLOTS
DEPTH (CM)
0
60
120
180
240
300
10
15
20
25
30
35
PERCENT SOIL MOISTURE
31/10/86
29/12/86
27/01/87
25/02/87
PLOTS IRRIGATED TO HARVEST
DEPTH (CM)
PERCENT SOIL MOISTURE
DRY PLOTS NOW IRRIGATED
DEPTH (CM)
PERCENT SOIL MOISTURE
IRRIGATED PLOTS NOW DRY
DEPTH (CM)
PERCENT SOIL MOISTURE

Effect of irrigation treatment on changes in soil water content through the season. Mean values of four tubes are given.

Second Trial

No responses to irrigation were measured on either site in the first year of this trial (1985-86). However, in the past season, grape yields increased linearly with irrigation rate on the stony site, with the low available water content (Figure 3). Again no response to irrigation was measured on the second site with the higher soil water holding capacity.

Figure 3



DISCUSSION

The response to irrigation in the trials described has varied with season and place. The largest response occurred where young vines (six years old) were irrigated to harvest. However, in later years the response appeared to decline. At this time, we were not sure whether this was a reflection of the increased rooting depth, thus making a greater volume of soil water available to the vines, or a reflection of a series of wetter than average seasons. In practice it would appear that both have a part to play.

The results suggest that the response of vines to irrigation will be greatest during the establishment years. At this time shoots are trained to give rapid canopy development, while the root system is small. This makes vines particularly susceptible to drought, which in our case was intensified by the impedance to root penetration caused by the fragipan at 30 cm depth. As vines get older, root growth occurred at depth (reflected in the water extraction patterns), particularly in the unirrigated treatments. This provides vines with a greater volume of soil water, and a lower dependence on irrigation. At the same time, further canopy development is restricted by pruning.

The role of the volume of water available to the vines, and its influence on irrigation response was shown further when previously irrigated vines were transferred to non-irrigated treatments. Where vines had been irrigated over several seasons, root development was more superficial. This made vines sensitive to the moderate drought experienced in the 1986/87 season. This drought had less effect on vines that had not been irrigated throughout the trial. A similar influence of the available soil water is also shown, where vines are growing on soil types of differing water holding capacities, with an irrigation response occurring only on the site with the low soil water holding capacity.

ACKNOWLEDGEMENTS

We appreciate the substantial assistance provided to us by Montana Ltd who have provided encouragement and considerable help in many aspects of the trials described here. In addition, the input of Ron Clare and Chris Morgan, who were instrumental in establishing the trial in 1980 is acknowledged.

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PLANT QUARANTINE

AND THE IMPORTATION OF GRAPEVINES

PLANT QUARANTINE

Plant Quarantine, as defined by Dr. Kahn in 1989 is "the use of exclusion as a control strategy against exotic pests and pathogens". Post entry quarantine is a preferred mechanism of plant importation because:

1) Exclusion is more effective than eradication. Canadian grape growers are fortunate in that many of the diseases causing economic losses in other parts of the world have not yet become established in Canada. Experience in other countries have shown that it is nearly always impossible and very expensive to try to eradicate a disease after it has been introduced. An example of this is the attempt to control grapevine fanleaf virus in the state of California.

2) People are major vectors of virus diseases. Although some viruses have natural vectors, natural spread of these diseases tends to be slow and localized. Historically, man has been implicated in the introduction and spread of diseases into new areas. Man can play an even larger role as a vector in today's world where transportation is much easier and faster.

3) Diseases are often symptomless. The expression of disease symptoms by a virus on a plant host depends on the host and the environment. Some symptoms may not be immediately visible until the plants have been established in a new area for some time. Some virus diseases may remain latent or show faint symptoms on one host while much more serious effects may occur if this host is grafted with another plant or if the disease spreads naturally to another plant.

4) Specific tests are required to detect viruses. As mentioned above, certain viruses may not express well defined symptoms in some hosts. Reliable detection of these viruses often cannot be carried out without the use of specific and sensitive tests.

Acceptable methods of prevention against the introduction and spread of virus diseases are:

1) The use of only disease tested material.

2) The use of adequate isolation for healthy crops from known sites of infection.

3) The use of resistant varieties to reduce effects of diseases when other means of control are not successful.

4) The suppression and control of natural vectors.

SAANICHTON PLANT QUARANTINE STATION

The Saanichton Plant Quarantine Station was established in 1965. The site of the Station in Sidney, on Vancouver Island, was chosen because of its isolation from commercial fruit growing areas and the mild climate which allows for the growth of any variety suitable for culture in Canada. The primary role of the Station was to allow the safe introduction of foreign varieties or breeding material. The responsibilities of the Station were quickly expanded from tree fruit to grapevine. Since 1990 the quarantine facilities are being used for all other nursery stock which cannot be imported directly into Canada by commercial enterprises because of fear of disease introduction.

The functions of the Plant Quarantine Station are:

1) The testing and release of foreign plants. This includes plants which cannot be certified for importation into Canada as required under the Canadian import requirements. Plants are maintained at the Station while they are tested for the presence of diseases. Following full testing, samples are released to the importer.

2) Testing and release of Canadian plants. The Station offers service to Canadian breeders and nurseries who wish to submit samples for virus testing before public release and distribution. After testing, this material can serve as starter material for Canadian certification and propagation schemes.

3) Elimination of virus infections. Plants found to be infected with virus diseases can be submitted to virus elimination procedures. After re-testing, the new plants are distributed.

4) Verification of foreign certification schemes. To verify the accuracy and insure the reliability of foreign certification schemes, samples taken by port offices from commercial shipments to Canada are sent to the Station and tested for the presence of economically important viruses. Results from these tests are used by the import section of the Plant Protection Division in deciding whether to continue allowing the importation of commercial shipments from foreign countries.

5) Maintenance and distribution of disease tested material. The Station maintains a collection of over 1094 varieties and selections of fruit trees and grapevines of which 290 are grapevines. Propagative material is distributed in Canada and internationally to commercial certification schemes, individual growers and nurserymen, and research establishments.

6) The development of new detection methods. Research Scientists and technicians investigate new methods of purifying and isolating virus agents responsible for virus diseases. The scientists apply the latest of detection methods to develop faster and more sensitive detection tests.

All plant varieties and selections arriving at the Station are individually identified. Information about the origin and destination of the material, the genus, species and name of each variety and the number of samples received of that variety are entered into a computer database. This database contains records of all material received at the Station since 1965. Every propagation and its location is individually noted and maintained in the database as well as all tests carried out on each propagation and all distributions made to outside consignees. Propagations are maintained under isolation conditions in screenhouses. The degree of isolation is dictated by the origin of the material, the potential for serious diseases in that plant sample and the requirements for vector control.

METHODS OF VIRUS DETECTION

Plant virus diseases are detected at the Station both by bioassay and the use of laboratory techniques. Bioassay is a procedure for determining the presence of a virus by measuring its effect on a living plant under controlled conditions. Both woody and herbaceous indicators are used to detect the virus. An indicator is a plant species or variety which has been selected for its sensitivity to certain plant viruses which are not always obvious on the host plant. This sensitivity expresses itself in the form of symptoms which can be seen more or less easily.

1. LABORATORY TECHNIQUES:

a) Serology (ELISA)

Serological detection of viruses is the test of preference. It gives rapid results within two days and allows for direct identification of the virus particle involved in the disease. Large numbers of samples may be processed quickly. However, this test may only be used if an effective antibody is available in sufficient quantities. Before an antibody can be produced, the virus must be purified and injected into an animal. The animal naturally and harmlessly produces antibodies to a foreign virus. These antibodies react with individual virus particles in laboratory tests allowing for the direct diagnosis.

b) Electron Microscopy

This highly sensitive and specific technology allows for the direct visualization of the virus particle. Its main application is in the area of virus research and purification. Viruses may be identified when this test is combined with serology. The virus particles are trapped onto the microscope grid and then decorated with antibodies. The result of this can be seen directly via the microscope. The electron microscope may also be used for diagnostic cytopathology. Certain viruses cause the plants to produce specific structures such as inclusion bodies and trabeculae in response to virus infection. These bodies may be seen under the electron microscope. Although the identification of viruses may be very rapid, often in less than one hour, this procedure requires expensive equipment and expertise. Its use is practical for examining small quantities of samples.

c) Nucleic Acid Hybridization

This highly specialized laboratory procedure is extremely sensitive and specific. Results are obtained within two days and the technology can be used for the detection of viroids, disease causing entities which are not detectable by serology. However, the procedure is expensive and requires a high degree of technical expertise. It is currently not being used for routine diagnostic work at the Station.

2. BIOASSAY

a) Herbaceous Host Indicators

Herbaceous indexing consists of rubbing a sample of ground plant tissues taken from leaves, roots or cambial scrapings onto indicator plants related to lamb's-quarters, cucumbers, squash or tobacco. This test is relatively rapid requiring only two to four weeks. It is also effective for detecting a broad spectrum of virus diseases, but it is difficult to identify a specific virus from amongst similar symptoms which may be caused from a variety of viruses. The main limitation of this detection technique is that it can only be used for viruses which are sap transmissible, that is which can be transferred by rub inoculation from the host plant to the indicator. Another limitation is that it is most sensitive during specific times of the year. The sample must be ground in a special buffer containing chemical components which protect the virus particle from degradation and allow it to be transferred to the indicator.

b) Woody Host Indicators

The use of grape or tree fruit varieties as indicators is the main method of detection used at the Station. It is the only detection technique that can be used for viruses which are not sap transmissible or have not yet been characterized. As both tree fruit and grapevine contain a number of viruses

which fall into this category, all varieties submitted to the Station are inoculated onto woody host indicators. Disease detection is incomplete and the varieties may not be fully released until the last symptom readings have been taken on the woody host indicators. Woody indicators are inoculated either in the field or by bench grafting using wood chips or bud chips. After inoculation, the indicator plants are examined once or more per year for up to three growing seasons in the case of grapevine indicators, and up to two cropping seasons for tree fruit indicators expressing symptoms on fruit. Some of the symptoms may only be observed by destructive sampling. In other words, the plants are dug up and the bark removed to observe symptoms on the wood cylinder. These indicators are often effective for detecting a broad spectrum of diseases. It may however, be difficult to identify one disease amongst symptoms which may be caused by a number of diseases. The procedure is time consuming requiring from three months to four years to complete.

VIRUS ELIMINATION:

Plants found to be infected with viruses may be submitted to virus elimination procedures. If the importer requests virus elimination, the Quarantine Station first reviews other sources of certified grapevine and tree fruit varieties to try to find another source which is free of viruses. If none is available, then the plant may be subjected to either heat therapy or treated with antiviral drugs.

Using conventional heat therapy techniques, a well rooted plant is placed in a growth chamber at a high temperature, usually 37^{0} C. During the treatment the plant will grow very slowly while the temperature reduces viral replication and titre. The plants are kept at this temperature for as long as possible, optimally for 100 days or more. Young growing tips of about 1 cm in size are grafted onto virus tested rootstock. Alternately the tips may be taken and introduced into tissue culture. The smaller tips taken for tissue culture often increase the likelihood of virus elimination.

Tissue culture or culture in vitro may also be used during heat therapy. The plant is introduced into tissue culture and the whole culture is subjected to the high temperature regime. Tips which are taken after therapy are also produced via tissue culture and eventually self rooted and transferred to pots.

Recent experiments have shown that antiviral drugs similar to those used against animal and human viruses are effective against some plant viruses. The drugs may either be applied as part of the growing media for plants grown in vitro or are applied as a foliar spray to plants growing under normal conditions.

The plants produced through virus elimination must be retested to determine whether the virus was truly eliminated. This final retesting is carried out on plants who have grown for two seasons following heat therapy.

IMPORTATION OF GRAPEVINES INTO CANADA

Canada, like many other countries in the world, has established import regulations which control the entry of plant propagative material of Vitis. These regulations spell out the conditions of entry and define specific requirements dealing with disease testing and certification in the country of origin. Only exporters from countries which have developed a certification scheme acceptable to the Canadian Plant Protection Division can ship commercial quantities of approved varieties to Canada. The plants must have been propagated and maintained in such a manner to prevent virus infection and to guarantee the identity of the material being shipped to Canada. As a result

of the Canadian import regulations, only certain American states and France is allowed to sell grapevines to Canada. The main American states involved are California, Washington, Oregon and New York.

France has recently been approved as a commercial source of grapevines for shipment into Canada. This approval came about after a thorough review by the Plant Protection Division of the French certification program propagation scheme and virus testing procedures. There are now nine French nurseries producing Category A varieties. Varieties in Category A are those which have previously been fully tested and are available for direct importation by a grower from one of the nine nurseries. Currently there are 17 clones of 9 rootstock and 26 clones of 12 varieties in this categroy. More varieties and rootstocks are being tested at the Quarantine Station. Testing has been started on twenty new variety/rootstock combinations this year alone. As testing is completed, these varieties will also become eligible for commercial shipment to Canadain Category A.

Varieties in Category B from France are those which have not yet been fully tested and obtained from the 9 approved nurseries. Limited quantities of these varieties and rootstocks are allowed to be imported into Canada. Samples are submitted to the Station for serological and herbaceous testing while the rest of the shipment is maintained in cold storage for up to 8 weeks pending the testing results. Following these results, the varieties may be planted in the vineyard in a quarantine plot. The quarantine is lifted after three years following the full testing results. For more information on importing Category B grapevines contact the nearest Plant Protection port office.

There has been recent interest in importing commercial grapevines from other countries. These countries must follow the same procedures used to approve the grape certification program in France. First, the Canadian grapevine industry must supply documentation and justification for an assessment of a foreign certification scheme to the Import Section, Plant Protection Division, Ottawa. The Plant Protection Division then carries out an assessment of this request for evaluation. The Division takes into consideration industry needs and departmental priorities. Following this a review of the foreign certification and propagation system is carried out. A written package is submitted by the exporting country which explains the disease indexing procedures, the production scheme, and the certification programs in place. At this point, varieties may be requested from mother plantings to be tested at the Plant Quarantine Station for virus diseases. The foreign certification system is compared with Canadian requirements. If the results are satisfactory an on site review of the production scheme is carried out by Plant Division officials in the foreign country. If the on site review is satisfactory then more samples are sent the Plant Quarantine Station for testing. Approval for commercial importation of grapevines from a new country may be allowed upon satisfactory completion of the testing results at the Plant Quarantine Station. As of this date, the certification schemes in Italy, Hungary and Switzerland have reached the on site inspection stage. Pending completion of a report the next phase will involve testing of clones submitted to the Plant Quarantine Station.

An import permit must be applied for and obtained from the Plant Protection Division in Ottawa before grapevines may be imported into Canada. The application forms for these import permits are available from the nearest Plant Protection Division office.

January 1991

LIST OF SOURCES AND GRAPESTOCK CLONES APPROVED FOR EXPORT TO CANADA FROM FRANCE/LISTES DES SOURCES ET DES CLONES (PLANTS DE VIGNE) APPROUVEES A EXPORTER AU CANADA DU FRANCE

Etablissements Chauvin
M. Jean Chauvin
Bd. Albin Duranc
84260 Sarrians
Vaucluse, France

Pepiniere Mercier Freres
La Chaignee
85770 VIX
France

Pepinieres Morisson-Couderc
07200 Vogue
France

Pepinieres Guillaume Sarl

Charcenne
70700 GY
Carpentras
Haute-Saone, France

Pepinieres Hyacinth Raymond

Chemin Carpentras-Morlemort
Boite Postale #8, 84200
Vaucluse, France

M. Guy Ozil Pepiniere Du Bas Vivarais
Les Mazes
07150 Vallon-Pont-D'Arc
France

Pepinieres Viticole

M. Jacques Gergaud
Nercillac
16200 Jarnac

Ets Jacques-Richard
Pepinieres Du Ventoux
84330 Caromb
France

S.A. Richter

Domaine-De-Saint-Clement
34980 St-Clement-La-Riviere
France

ROOTSTOCK/PORTE GREFFE

3309	Clones 111, 143, 144
41 B	Clone 153
161-49C	Clone 176
5 BB	Clones 106, 114
Richter 110	Clones 7, 151, 6
42 A	Clones 10, 11
101-14	Clone 3
SO4	Clones 5, 102, 166
RSBI	Clone 109

VINIFERA TYPES/GENRE DE VINIFERA

Cabernet Sauvignon	Clones 169, 339
Chardonnay	Clones 75, 76, 95, 96
Chazan	Clone 538
Colombard	Clone 551
Gamay	Clones 356, 358, 509, 232
Merlot	Clones 184, 346, 447
Pinot Noir	Clones 115, 164, 375
Sauvignon Blanc	Clones 241, 297, 378
Ugni Blanc	Clones 479, 485
Gamay Noir	Clone 282
Merlot Rouge	Clone 181
Muskat de Hambourg	Clone 202

IRRIGATION/CROP LEVEL STUDIES AT WSU–IAREC

Sara E. Spayd, Robert G. Evans and Robert L. Wample

Associate Food Scientist, Associate Agricultural Engineer and

Associate Horticulturist, respectively.

Irrigation is an important management tool for Eastern Washington grape growers. Annual precipitation for most of the growing areas in this region is below 10 inches. Despite the ubiquitous use of irrigation for eastern Washington wine grape production, prior to the inititation of the study described here, little to no research was conducted on irrigation management of Vitis vinifera in Washington. We also felt that often too much water is applied. In 1981 the outline of a study to attempt to determine irrigation management techniques began to evolve. We decided that as a part of this study, crop load or crop level management should be an integral part since irrigation management can alter vine size and the vine's ability to produce consistent yields of high quality grapes. Additionally, three cultivars were selected for the study with varying degrees of winter hardiness: Riesling (most hardy), Cabernet Sauvignon and Chenin blanc (least hardy).

Irrigation is not permited in the majority of European wine regions. Wine grape irrigation is practiced in many parts, but not all, of California and Australia and is necessary for grape production in Israel. Most of the irrigation research was conducted in these three areas. Most of the California irrigation research was on the table grape cultivar Thompson Seedless.

The goal of our research was to optimize irrigation applications, keeping in mind the demands of different crop loads and cultivars, in order to manage vine canopy and fruit and wine composition.

Literature Review.

In order to put our study in context, a review of previous research is necessary. Smart and Coombe (1983) reviewed water relations in grapevines. Water stress reduces grapevine fruitfulness (Alexander 1965; Buttrose 1974; Hardie and Considine 1976). Well watered vines produced twice as much fruit as severely stressed grapevines (Smart et al. 1974). Irrigation during stage I of berry development resulted in increased yield, while irrigation during stage III resulted in little or no increase in yield as to nonirrigated vines (Ruhl and Alleweldt 1985). Sugar content was not affected by use of irrigation during stage I of berry growth, while it was generally increased by irrigation during stage III (Ruhl and Alleweldt 1985). VanZyl (1984) concluded that the highest possible soil moisture regime should be maintained during flowering and fruit set in order to insure maximum fruit set and cell division. Hepner et al. (1985) reported that irrigation cutback during the final six weeks of the growing season advanced fruit maturation. Amount of irrigation water applied affected vine growth of Cabernet Sauvignon more than yield, thereby altering the yield to pruning weight ratio (Hepner et al. 1985). The yield to pruning weight ratio was positively correlated with wine quality and color and the tartaric to malic acid ratio of the must. Riesling vines in Australia had higher fruit weight and bunched/vine when irrigated (McCarthy and Coombe, 1985). Fruit maturation was delayed by irrigation. Concentration of free terpenes in Riesling juice was not affected by irrigation, but

concentration of bound terpenes in juice from irrigated vines was half of that of juice from nonirrigated vines (McCarthy and Coombe 1985). Matthews et al. (1987) found that yield of Cabernet franc grapes was decreased more by early season water deficits than by late season water deficits. Full season, pre-veraison and post-veraison water deficits increased juice and dermal extract phenol content and dermal anthocyanin content as compared to those from well watered vines (Matthews and Anderson, 1988). There was no effect of water deficit or timing of water deficit on the onset of veraison, harvest date, juice pH, and potassium content; and there was little effect on Brix or titratable acid content. McCarthy and Coombe (1985) found that crop removal (thinning) from irrigated vines resulted in higher concentrations of bound terpenes in juice, with some of the juices from thinned, irrigated vines having a higher terpene content than nonirrigated vines. They inferred that the effect of irrigation on increasing crop yield probably plays a more important role in terpene content than the act of irrigation itself. Cropload effects on wine and wine grape quality were reviewed in 1985 (Spayd 1985). In general increased cropload retards sugar accumulation in the fruit, thereby delaying harvest. Other effects of altering cropload by pruning and/or thinning are often less clear because in much of the previous research, grapes from all treatments were harvested when control plots reached harvest maturity. Therefore, differences in grape and wine composition due to cropping level were confounded by fruit maturity.

WSU-IAREC Irrigation Project.

During the spring of 1983, the year of vineyard establishment, the site was graded (3% slope north east to south west); fertilized with macro- and micro- nutrients based on

soil test and WSU recommendations; and fumigated with methyl bromide to reduce weed problems and residual disease pressure from previous crops. Five km of underground irrigation lines were installed. The study was designed insuch a way that about every 35 vines have their own mini-irrigation system. The system is set up with a series of selenoid valves that are controlled by a computer program.

Six volumetric lysimeters were installed in the center of the vineyard in order to determine the actual amount of water used by a well (as in abundantly) watered vine. Each lysimeter, which is lined with 20 mil PVC, is six feet deep, 12 feet long and 10 feet wide and contains two vines of a single cultivar. Prior to filling the lysimeter with soil, ceramic vacuum drainage tubes were installed in the bottom to allow for removal of any free standing water. The soil is a windblown silt loam loess which is very uniform to at least six feet in depth.

Own-rooted vines were planted on a 6' x 10' spacing in mid-June, which is late planting for Prosser, at a depth of 12-14 inches and given a heavy watering. Due to the depth of planting, the hole is initially only partially filled. Vines were watered until the fourth of July. Irrigation was withheld until the vines were watered-in for the winter just prior to the close of the irrigation season in late October. The base of the vines was covered using a tractor mounted disc-hiller. Of the roughly 2200 vines planted only two had died by the following spring. It should be noted that vines were "watered-in" every winter in either late October or early November. This is a standard practice in eastern Washington to reduce if not prevent cold injury to vine roots.

During the spring of 1984, the trellis system was installed using a post for every plant. A cordon wire (4'), two wind catch wires (5'), and a wire (1') to support the

irrigation line were installed with a metal T on every other post. Initially vines were trained to a bilateral cordon system with a single trunk. Vines were allowed to grow under uniform irrigation and pruning practices for the 1984 and 1985 growing seasons. Irrigation and crop level studies were to begin in 1986. However, in November 1985 temperatures during the first week set high temperature records for the period at 80° F plus and by the last week low temperature records for the period were set at -8° F. In spring 1986 vines were cutoff at the ground, and two-trunked bilateral cordon vines were established. In order to dilute the growth encouraged by the now four year old root system, an additional pair of trunks were trained along the drip irrigation wire. This set of trunks was taken down and buried for the winter of 1986-87. The vineyard was allowed the 1986 and 1987 growing season to reestablish and treatments were initiated in 1988.

In 1988, irrigation schedules of 90, 80 or 70% replacement of water lost due to evapotranspiration (ET) were initiated at bunch closure. However, the 70% ET replacement was not sufficiently severe to affect vine performance. Therefore, in 1989 and 1990 irrigation schedules of 90, 60, or 30% replacement of ET were initiated at bunch closure. Incorporated into the replacement schedule was a crop coefficient which changed based on the water needs of the vine. The coefficients were derived from a previous study of R. G. Evans and from the lysimeter data. The maximum value for this coefficient occurs just prior to harvest. Water applications were pulsed on to keep the water within a restricted area and to prevent runoff into adjacent plots.

In each year, the vines were balance pruned to either 5, 10, or 15 nodes/ 0.45Kg of dormant pruning wood (dpw) for Riesling and Cabernet Sauvignon. Chenin blanc vines were pruned to either 3, 6, or 9 nodes/0.45 Kg dpw. Vines were then balance thinned just

after bloom to the same schedules in order to maintain the desired number of shoots/vine. Fruit maturation of Riesling and Cabernet Sauvignon was delayed by the 90 versus the 30% ET replacement. Leaving more nodes/shoots increased fruit yield. Fruit maturation of Cabernet Sauvignon and Chenin blanc was delayed by leaving a larger number of nodes/shoots.

In general neither irrigation nor crop level had a tremendous impact on grape or wine composition. This was true even when crop levels varied by as much as 6 tons/acre. It should be noted that all fruit was harvested when an equivalent soluble solids concentration was reached (20-21% for Riesling and Chenin blanc and 22-23% for Caberent Sauvignon). Of the three cultivars, the number of days from bloom to harvest Cabernet Sauvignon was most affected by irrigation and crop level.

Summary.

Although the study was initiated in 1983, irrigation treatments are still evolving. Cabernet Sauvignon and Chenin blanc sustained freeze injury, primarily buds, during late December 1990. Riesling weathered the cold. Therefore, our 1991 treatments are only on Riesling, while the other two cultivars will be allowed to outgrow injury (was not treatment related). We are now looking at a full season treatment schedule where the 90, 60 and 30% regimes will be imposed throughout the growing season.

Our goal is to find an irrigation regime that will allow for efficient utilization of water by the vine with canopies that require little or no manipulation and yields of high quality fruit that mature within the growing season in eastern Washington.

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Malolactic Fermentation of Wines

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The malolactic fermentation (MLF) is the bacterial conversion of malic acid to lactic acid with the loss of carbon dioxide. The fermentation is usually carried out by species of the genus Leuconostoc, although other genera including Pediococcus and Lactobacillus spp. can also catalyze MLF. In contrast to alcoholic fermentation where grape must is directly inoculated with wine yeast, winemakers may rely on native strains of malolactic bacteria to carry out MLF. However, this practice can often lead to unpredictable results. To improve predictability, strains of malolactic bacteria, primarily Leuconostoc oenos, have been isolated from wine regions around the world (Beelman et al. 1977; Chalfan et al, 1979; Costello et al, 1985; Ingrahan et al., 1960). Although some workers have found little if any improvement in the predictability by direct bacterial inoculation, others were more successful (Beelman and Duke, 1985; Beelman and Kunkee, 1985; Costello et al., 1985; Ingraham et al, 1960; Rankine, 1977).

Currently, several strains of malolactic bacteria are commercially available either as freeze-dried or liquid cultures. Freeze-dried cultures offer the advantages of being easy to work with and can be stored for long periods. However, these cultures are often not acclimated to wine. Liquid cultures are actively growing when they

reach the winery and as a consequence, need to be used soon after arrival. Liquid cultures have the additional disadvantage of potential problems during shipping (temperature increase; transportation delays, etc.).

Inoculation rates of cultures into wines are commonly 10^6 CFU/mL of wine (CFU = colony forming units. CFU is used because it is not equivalent to total number of cells). Winemakers frequently use a 2% inoculum of an actively growing culture. Higher amounts of inoculum (3-5%) are suggested for those wines that may have higher amounts of inhibitory factors (e.g. white wines with lower pH and higher SO_2). A good review article on starter culture preparation and build-up can be found in Blackburn (1984).

Since early work by Pilone and Kunkee (1965) and Pilone et al. (1966) observed few differences in the sensory characteristics and chemical composition of wines fermented by various strains of bacteria, it appeared that any strain could be used to induce MLF. However, this does not appear to be the case since strains have varying tolerances to low pH, sulfur dioxide, and temperature. Strains can also variably alter sensory quality (Giannakopoulos et al, 1984; McDaniel et al, 1987; Rodriguez et al, 1990). Beelman et al. (1980) suggested that indigenous bacteria may grow better and induce a faster MLF in wines of that particular region than strains isolated elsewhere. In support, Beelman et al. (1977) isolated L. oenos strain PSU-1 which induced a faster MLF in Pennsylvania wines from where it was isolated than did ML-34 isolated from a California wine (Ingraham et al., 1960). Costello et al. (1985) and Watson (1986) reported similar observations.

The primary objective of our work at Washington State University was to isolate and characterize native strains of malolactic bacteria and evaluate their ability to catalyze MLF in Washington wines. In the summer of 1989, wineries in Washington were asked to complete a written survey of enological practices performed at their wineries. Using this information, wines were collected from those wineries where MLF was encouraged without using commercially available cultures. A total of 39 samples representing 14 wineries were collected (Figure 1).

Native strains of malolactic bacteria from these wines were isolated and identified using standard techniques including Gram stain, colony and cell morphology, catalase production, type of lactic acid (D, L, or DL) produced from glucose, gas from glucose, ammonia from arginine, and carbohydrate utilization. Species of Pediococcus spp were further identified on the basis of growth at different pH, NaCl concentrations, and temperatures. A total of 16 strains of Leuconostoc oenos, 10 strains of Pediococcus spp. including P. parvulus (9 strains) and P. inopinatus (1; tentative identification), and 15 strains of Lactobacillus spp. were isolated. Lactobacillus spp. have not yet been identified to species level.

Tolerances of native strains of L. oenos to pH (pH 2.9. 3.3, 3.5, and 4.5), temperature (12°, 25°, and 30°C), and sulfur dioxide (0, 15, and 30 mg/L total SO_2 at pH 3.5) were compared to those of commercial strains including ML-34, MCW, and PSU-1. Pure cultures were inoculated into synthetic media (modified apple Rogosa) with the appropriate additions and growth was monitored by optical density (Klett meter). Most strains grew well at pH 3.3 to 4.5 while none grew

at pH 2.9. Growth of all strains was retarded at 12°C and 30 mg/L total SO_2 although differences in growth were apparent. Ability to induce MLF in Washington state wines is shown in Figure 2. Differences in time to complete MLF comparing native and commercial strains were observed in Merlot, Cabernet Sauvignon, and Chardonnay with several native strains completing the fermentation faster. Volatile acidities (VA) of the Merlot wines ranged between 0.029 g/100 mL to 0.044 g/100 mL (Table 1), all within acceptable levels. Data from these experiments has been accepted for publication (Edwards et al., 1990; Jensen and Edwards, 1990).

Strains of Pediococcus spp. were also grown at different temperatures (12°, 25°, and 30°C) and sulfur dioxide (0, 15, and 30 mg/L total SO_2 at pH 3.5) and ethanol (0, 10, 12, 14% v/v) concentrations. Some strains, namely P. parvulus WS-7C, WS-9, and WS-12, had higher tolerances to sulfur dioxide in comparision to the other strains characterized. Most strains were able to grow in 12% ethanol but not in 14% with the exception of P. parvulus WS-29A which could tolerate this concentration of ethanol.

Of the commercial wines from which strains of Pediococcus spp. were isolated, several were of relatively high quality. This finding contradicted the generally accepted belief that growth of pediococci in wines was undesirable due to formation of off-odors or flavors. Whether enhancement of wine quality was a result of 1) growth of certain species and strains of Pediococcus (i.e. P. parvulus), 2) metabolic interactions between Pediococcus spp. and L. oenos also isolated from these wines, 3) factors not associated with the growth of

pediococci such as the winemaking practices at the winery, or 4) a combination of these remains unknown.

To study the growth of pediococci in wines and any impact on quality, MLF was induced in a Merlot wine (1990) with a strain of Leuconostoc oenos and then reinoculated with 4 strains of P. parvulus. Growth of pediococci was observed in all of the wines. Interestingly, the initial population viabilities of all strains were greatly reduced in wines with previous MLF catalyzed by L. oenos. This obsevation was not seen in wines without MLF. These data indicate that an antagonistic relationship exists between the strains of L. oenos and P. parvulus studied.

A second objective of the project is to identify and quantify volatile compounds produced during vinification and to determine factors that influence their synthesis by yeast and bacteria. Differences in chemical composition and sensory characteristics between wines fermented by different strains of malolactic bacteria have been observed by winemakers but not studied in depth. Future studies will evaluate production of volatile compounds by different bacterial strains including Pediococcus sp. using gas liquid chromatography-mass spectrometry (GC-MS).

We have also begun to study the interaction between wine yeast and malolactic bacteria. Evidence concerning the nature of the antagonistic factor(s) between microorganisms including wine yeast is currently lacking, especially with regards to any relationship(s) between Lactobacillus sp. and wine yeast. Studying these interactions can lead to development of techniques to be able to easily encourage or prevent MLF when desired.

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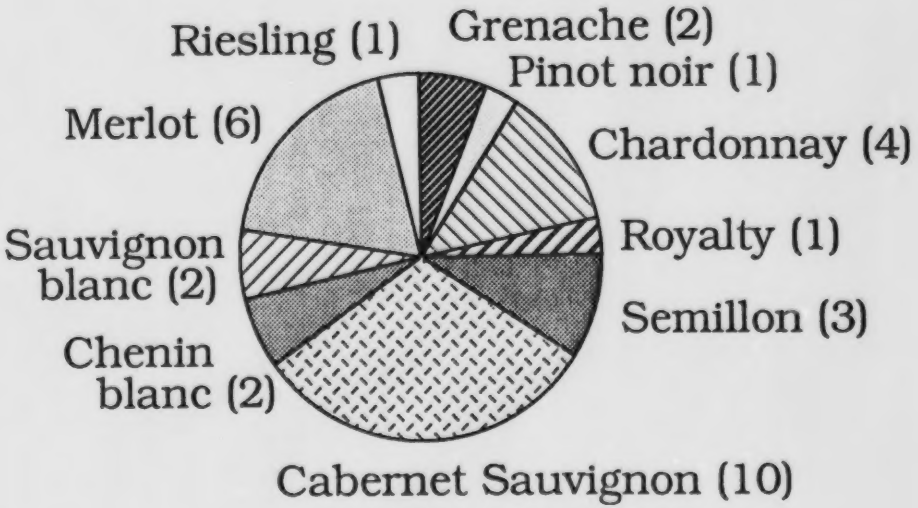


Figure 1. Distribution of commercial wine lots by grape cultivar. Numbers refer to the number of samples collected.

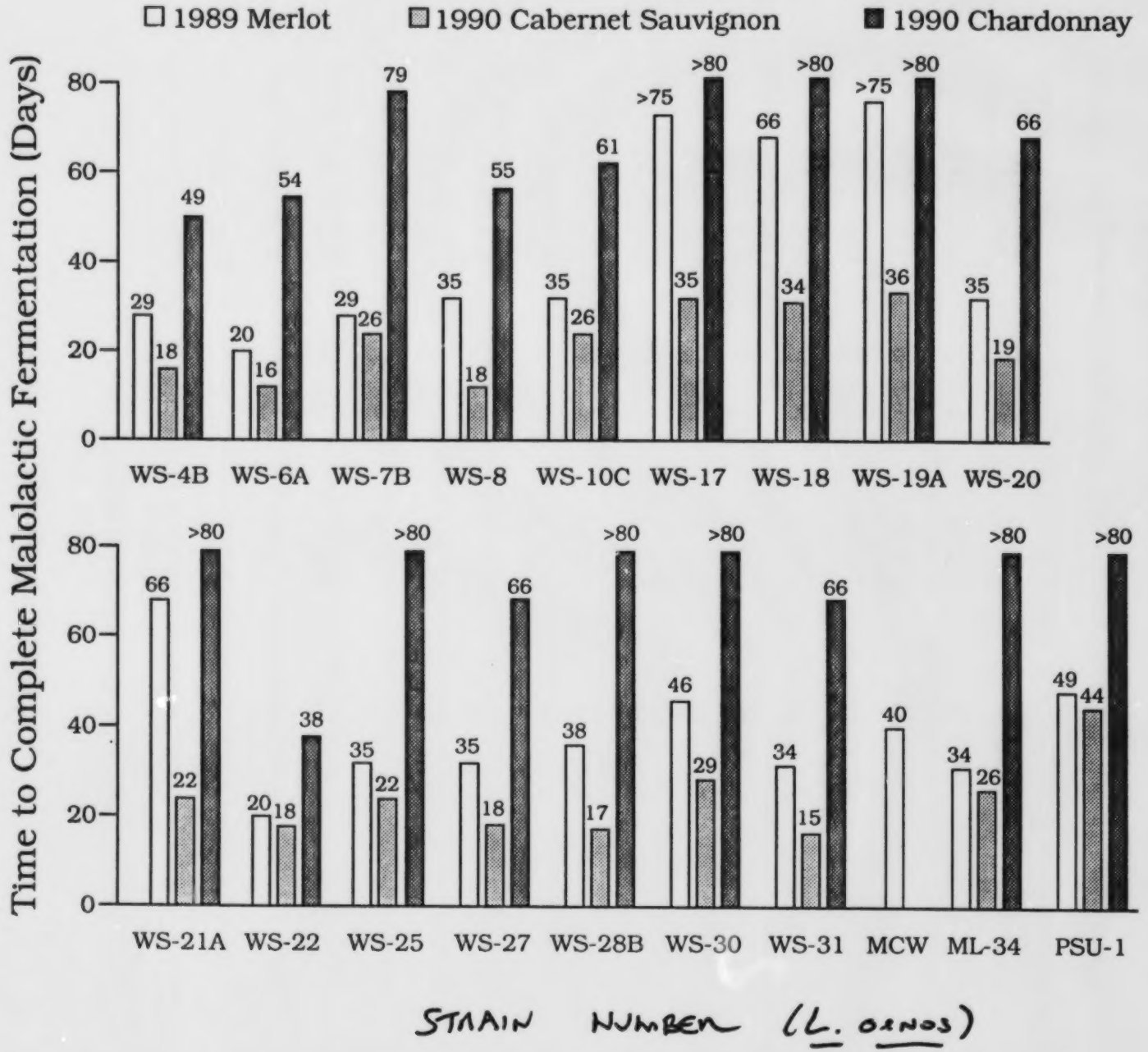

1989 Merlot
1990 Cabernet Sauvignon
1990 Chardonnay
Time to Complete Malolactic Fermentation (Days)
0
20
40
60
80
WS-4B 29 18 49
WS-6A 20 16 54
WS-7B 29 26 79
WS-8 35 18 55
WS-10C 35 26 61
WS-17 >75 35 >80
WS-18 66 34 >80
WS-19A >75 36 >80
WS-20 35 19 66
WS-21A 66 22 >80
WS-22 20 18 38
WS-25 35 22 >80
WS-27 35 18 66
WS-28B 38 17 >80
WS-30 46 29 >80
WS-31 34 15 66
MCW 40
ML-34 34 26 >80
PSU-1 49 44 >80
STRAIN NUMBER (L. OENOS)

Fig. 2

Table 1. Chemical analysis of 1989 Merlot

Strain	pH	Titratable acidity[1]	Volatile acidity[2]
WS-4B	3.78	0.50	0.037
WS-6A	3.77	0.51	0.044
WS-7B	3.78	0.52	0.039
WS-8	3.75	0.51	0.033
WS-10C	3.75	0.52	0.038
WS-18	3.78	0.49	0.030
WS-20	3.79	0.50	0.029
WS-21A	3.77	0.51	0.033
WS-22	3.77	0.52	0.035
WS-25	3.80	0.51	0.034
WS-27	3.81	0.50	0.030
WS-28B	3.78	0.51	0.037
WS-30	3.83	0.51	0.036
WS-31	3.81	0.51	0.032
MCW	3.81	0.51	0.036
ML-34	3.78	0.51	0.035

[1] g tartaric acid/100 mL

[2] g acetic acid/100 mL

OREGON STATE UNIVERSITY
VITICULTURE-ENOLOGY COOPERATIVE RESEARCH

S. F. Price, B. T. Watson, and P. B. Lombard

Lewis-Brown Farm Trellis Trial

The trellis trial at the Lewis-Brown Farm was initiated in 1983 to examine potential trellis systems for Oregon winegrapes. Two issues were regarded as very important to the Oregon winegrape industry in 1983: problems with excessive vigor and the exciting potential of double curtain canopy systems to raise yields and improve quality. The trellis trial was designed to address those questions. Seven years later, we are starting to get some answers and have begun to ask several more questions.

The trial is located in Linn County near Corvallis on the valley floor. When the trial was established, this location was thought to be very vigorous. It has not turned out that way. The soil is a sandy loam overlaying a gravel layer. This soil has a fairly low water holding capacity, and as a result the vines have not been overly vigorous. Supplemental irrigation has been required each year to prevent vine defoliation from water stress. Grape maturity has also been much earlier than we anticipated. The Pinot noir has ripened within a few days of Pinot at Woodhall III Vineyard (a warm site with a southern exposure). Although the vineyard site is not "typical" of most Willamette Valley vineyards, vine response is far more representative than we had hoped.

The trial consists of five trellis systems: standard upright vertical, cordon upright vertical, Scott Henry, lyre, and Geneva double curtain, and four varieties: Pinot noir, Chardonnay, Reisling, and Gewurztraminer. The standard and cordon treatments are spaced 1.5 x 2 m and the double curtain systems are spaced 1.5 x 3 m. All the treatments

were pruned to the same number of nodes per m^2 ($5.3/m^2$ or $0.5/ft^2$). This node density is similar to standard pruning systems used in Europe and is slightly higher than the usual node density used in Oregon vineyards. The close row spacing, however, results in a fairly low node number per meter of row (8 nodes/m for the single canopy systems and 6 nodes/m for the double canopy systems). These low node densities per meter of canopy have had a major impact on the results we are getting from the trial. Most trellis research has been done at higher node and shoot densities. These higher levels may tend to increase the differences between double and single canopy systems.

The vines have been in full production for two seasons. Crop levels for the 1990 season ranged from an average of 2.5 tons/acre for Pinot noir to 3.5 tons/acre for Reisling. This was about half of the 1989 crop level. Inflorescence necrosis was severe in all varieties, but particularly Gewurztraminer which had a total crop failure this year.

Yield responses in 1990 were similar to 1989 in that the highest yielding canopy varied for each variety (Fig. 1). For the second year, the cordon treatment yielded better than expected. Pinot noir had the highest yields on cordon and Chardonnay had higher yields with cordon pruning than cane pruning. The cordon's higher yields in Pinot noir was largely due to an increase in clusters per vine. The Geneva double curtain had the highest yields in Chardonnay, yielding 1 ton/acre more than the upright vertical cane treatment. The upright vertical cane pruned system had the highest yields in Riesling with both the largest clusters and the most clusters/vine.

Fruit composition was monitored both by must samples and by berry samples taken in the field. However, there was a discrepancy between the two methods in the Pinot noir samples. The usual field sampling procedure is to take a 200 berry sample from each

treatment for each replication (a 200 berry sample from eight vines). This sample did not correlate with the must sample for Pinot noir (Fig. 2). The berry sample showed distinct treatment effects on TA with a very low TA on the GDC. The must samples had substantially lower TA and had no treatment response. With this in mind, we sampled the Chardonnay with three separate samplers and kept the must lots separate by replication (Fig. 3). Although there was a difference in absolute values, the relative differences between treatments were similar. The cordon treatment had the highest TA and GDC had the lowest.

Overall, the differences between trellis systems were generally small, much less than many of the trellis experiments that have been reported in the literature. The low shoot density probably results in a smaller canopy effect on cluster environment than in many trials and the low crop level in 1990 also decreased treatment differences. Preliminary evaluation of wines, however, indicates that treatment differences may be more pronounced than would be indicated by yield and grape composition results. Pinot noir wine from the double canopy systems had significantly higher color and total phenols. Wine analytical and sensory data will probably result in the most important treatment differences observed this year.

Shoot Density Trial

This trial was established to evaluate the effects of shoot density and yield on Pinot noir wine quality. 1990 was the second year of the trial. Field work on this trial will end in 1991. Dr. Andy Reynolds of Agriculture Canada is collaborating with us on this trial and has established similar field experiments in British Columbia.

The trial includes three shoot densities: 10, 15, and 20 shoots/meter and two cluster thinning treatments (none and 50% of the clusters removed). All the treatments are trained to an upright vertical trellis except the twenty shoot/meter treatment which includes both and upright trellis and a vertically divided trellis (a Scott Henry trellis).

The 1989 results were dramatic and clear-cut. Increased shoot densities and higher yields adversely affected grape composition, particularly sugar accumulation (Fig. 4). The data from 1990 is not as clear. Yields in 1990 were 50% less than 1989 yields (Fig. 5), averaging only 1.9 kg/vine (1.7 tons/acre). None of standard measures of grape composition were affected by shoot density and only brix was affected by cluster thinning (Fig. 6).

Wines were scheduled to be made from this trial this year but, because of the low yields, only the unthinned treatments were included in wine trials. Wines from the Scott Henry treatment had greater intensity and more color than wines from the upright systems. Wine making trials in B.C. found significant treatment responses to both cluster thinning and shoot density in 1989.

Despite the scarcity of major treatment responses for grape composition, there were some very interesting correlations (and lack of correlations) between measured parameters. Brix had no significant correlation with yield. This same result was found in 1989. There was a strong correlation between TA and brix ($r = -0.709$), but only a weak correlation between TA and pH ($r = -0.259$). TA also correlated with leaf layer number ($r = 0.511$), a measure of the canopy density. The strongest correlation with pH was with cluster weight ($r = -0.537$), which was something we had not observed before. Cluster weights in the trial were very low and averaged only 44 g. In 1989, cluster weights in the Woodhall trial averaged 66 g and in B.C. they averaged 130 g.

We would expect these shoot density and cluster thinning treatments to have a greater effect in a year, with higher yields (we are hoping for a good set in 1991), but even at these extremely low yields we did get some responses. Average yield for the non-cluster thinned treatments was only 2.2 tons/acre. Cluster thinning reduced yields to 1.3 tons/acre and resulted in a significant increase in Brix.

How low must yields be to get "optimum" quality? Can improved canopies raise the lower threshold for optimum quality? These are the questions we will be concentrating on as we continue this research.

Growth Diversion Using Disposable Canes to Reduce Vegetative Growth

The objective of this project has been to develop a method to reduce vegetative growth in grapevines. Excess growth and dense canopies reduce wine quality and increase disease incidence, specifically botrytis bunch rot. Over the last four years, we extensively tested a method of reducing vegetative growth by a technique called growth diversion (GD).

Growth diversion is a pruning technique that reduces growth in the fruiting canopy by diverting growth to a second, disposable canopy. A typical standard pruning system would leave two fruiting canes per vine. The GD system would use two fruiting canes plus two or more additional canes containing at least twice the number of buds of the fruiting canes. These canes are kept separate from the fruiting canopy and are usually trained along the ground. After fruit set, these extra "disposable" canes are removed. The initial concept was that this system would divert growth from the fruiting canes to the disposable canes, reducing total vine growth. By removing the canes at shatter, potential problems (such as poor quality) resulting from an excessive crop would be avoided.

The major goal of the experiments was to determine vegetative responses. In all the experiments, vines were trained to an upright, vertical canopy. None of the experimental vines were hedged or summer pruned except for the removal of the disposable canes. Cane pruning weights were taken each year to evaluate total growth. Yield and grape composition data was collected each season. All of the research was conducted at Woodhall III Vineyard in Alpine, Oregon.

Growth diversion has proven to be a very effective method of reducing vegetative growth (Fig. 7). In four years of trials, using three varieties, growth diversion reduced pruning weights an average of 29%. There was a 50% reduction in pruning weights in Pinot noir in 1987 and in Chardonnay in 1989. The number of shoots per vine was reduced in several of the experiments, but the main effects seemed to be a reduction in shoot length, lateral number, and shoot thickness.

Yield was not affected by GD in any of the experiments. However, an increase in berries per cluster and seeds per berry was observed in 1987 on Pinot noir, along with a decrease in berry size. There were variable effects on grape composition. Brix was not greatly changed in these trials. Growth diversion lowered the pH in Pinot noir, and in Chardonnay it reduced TA. Wine was not made from any of these experiments, but with the large change in canopy density and the change in acidity, it is likely that wine characteristics would be affected by GD. In other canopy trials at OSU, treatments that reduced canopy density usually increased color, even if brix, TA, and pH were not affected.

This project was concluded in 1990 with two large experiments: one on the effects of the number of nodes left on the disposable canes and a second on the timing of disposable cane removal. These data have not been completely analyzed. Visual

observations during the growing season suggest that both timing and bud number have major effects on vine growth responses.

The concept of growth reduction though growth diversion was more successful than we anticipated. At Woodhall III Vineyard it was a very effective way to improve canopy density. It is not appropriate, however, for growers to assume that this system will solve all their canopy problems. But the system has been too effective in our trials to dismiss it as just another odd idea from the "academic types". It is a promising concept that needs to be approached with a degree of caution.

First, there are several questions about growth diversion that our experiments did not address. The most important is how the system would perform on a very vigorous site. It's possible that on a site with very deep soil, or a site where water is available throughout the season, that GD would not give an adequate reduction in growth. At a site like Woodhall, where vigor is only slightly more than desirable, it's possible that continued use of the system would be too devigorating. In our trials, vines were only "subjected" to vigor diversion for one season and different vines used for the next season's experiment. It's probable that the GD system will have to be adjusted to each site.

There are three points that came out of these trials that are clear and they are points growers should note:

1) The growth diversion experiments illustrated an important point about vine growth. The growth of individual shoots is largely a function of how many shoots are growing on the vine. Growth diversion reduces individual shoot growth by greatly increasing the total shoot number per vine. This same concept is evident in many other viticultural practices from vine response to light pruning to the growth responses of

vines with divided canopies. These experiments also illustrated that under typical Oregon conditions, the high shoot numbers do not have to be present the whole season to get the desired growth reduction.

2) Growth diversion is one of the easiest ways to test a vineyard's response to a lower canopy density. This system allows a grower to modify vine growth without going to the expense of changing trellis systems or even changing crop load. If vines respond to growth diversion with an improvement in acidity, sugar, color, yield, or botrytis incidence, then the vineyard has a canopy density problem and permanent remedies should be considered.

3) The concepts inherent in growth diversion could be used with a Scott Henry trellis system both to reduce vigor and to regulate yield levels. We have started a set of experiments to evaluate the Scott Henry trellis with one modification--we are treating the lower canopy of the trellis as "potentially disposable". In a vigorous vineyard, the lower cane on the Scott Henry system can be treated like the disposable cane of the GD system. In a normal year it can all be disposed of after shatter but in a year with poor fruit set, part or all of it could be retained to achieve an acceptable yield. This system would reduce growth every year and it offers a more cost effective way of adjusting yields than cluster thinning.

Growers interested in experimenting with growth diversion are encouraged to call Steve Price, Bernadine Strik, or Porter Lombard at Oregon State University. We would be glad to help set up grower trials to test this system in a range of conditions. A grower interested in testing this system in their vineyard should be looking for the answers to three

key questions: Does it reduce growth? Does the growth reduction improve fruit composition or disease incidence? Are the benefits worth the added management expense?

The role of the OSU research program in this project has been to develop a new technique to deal with a common problem and to test its potential. We can assist in the next step of finding applications for the concept, but the final step of fitting the technique into a usable, profitable management technique is the grower's responsibility.

Grower Experiences with Growth Diversion

Several growers in Oregon and California have experimented with the growth diversion system. The following is a brief description of their experiences.

Cooper Mountain Vineyard: Corine and Bob Gross experimented with growth diversion on an experimental basis in 1988. They found that the system generally worked well and did reduce vine vigor. They were pleased with the resulting wines, but they found the system to be a bit of a management problem. They did not use the system in 1989 or 1990.

Tualatin Vineyards: Dave Foster, vineyard manager at Tualatin, used the growth diversion pruning system on all 70 acres of Tualatin vineyard this year. He is looking for an alternative to repeated hedging and leaf removal. He estimates that leaving the additional disposable canes during pruning took an extra five hours per acre.

Robert Mondavi Winery: Andy Bledsoe, a researcher for Mondavi, tried growth diversion in a vigorous block of Sauvignon blanc. They left two fruiting canes per vine and left 2, 4, 6, and 8 disposable canes per vine. The system reduced vegetative growth but there was no difference in fruit brix, TA, or pH. The following year the vines were pruned normally but there was a carry-over effect. Vines that had been pruned with the vigor diversion system the previous year had less growth. The effect was more pronounced on the vines that had

had more disposable canes. They are going to try the system again, but this time on a red variety.

Domaine Chandon: Zack Berkowitz, vineyard manager for Domaine Chandon, tried growth diversion on Pinot noir and Chardonnay in Carneros in 1989. They found the system to be difficult to manage and did not get much of a response. They politely blamed some of this on their management problems, but they have not tried the system again.

Pinot noir Clones

Pinot noir is the most widely planted grape variety in Oregon. It is also the most diverse. Within the variety there are a range of types that differ significantly in growth habit, production, and quality. The variation within the variety is great enough to have a major impact on the composition of the grapes, the quality of the wine, and the production of the vineyard.

Pinot noir planting material is usually listed with a selection name or clonal number or name. A selection is a group of plants that share a common origin. Usually they come from a single vineyard block that was selected for some desirable characteristic. They are usually named for the source vineyard block or vineyard. Clones are also plants that share a common origin, but in this case the origin is a single plant. Pinot noir vines of the same clone should be genetically similar, and identical to the mother plant. They are usually numbered. The number identifies the clone without ambiguity and usually can be used to trace a clone back to the source plant. Clones sometimes acquire names but these can be misleading. It is always best to know the identifying number.

Pinot noir generally has a floppy prostrate growth habit, small tight clusters, and low yields, but clones have been selected that vary from each of these characteristics. In the

trials at Oregon State University, Pinot noir clones fell out into at least four groups: standard types, upright types, fruitful types and loose-clustered types.

Upright clones were perhaps the most distinct. They are characterized by very upright shoots and fairly high yields. This group is known as Pinot droit in France and Gamay Beaujolais in California. They are well adapted to vertical upright training systems. Their large cluster size and high yields can result in lighter red wines.

Pinot fructifier or fruitful Pinot noir clones are typified by their extreme fertility. They have more fruitful shoots per vine, more clusters per shoot, and more flowers per cluster than the other types. As a result, they have very high yields for Pinot noir. They are not generally suited for red wine production unless there is some form of crop control practiced. These clones may have a place as a method of reducing annual variations in yield. Pinot noir is prone to problems with poor fruit set in years when there is cool wet weather during bloom. As a result, yields often vary considerably from year to year. A portion of a vineyard can be planted to these clones for insurance in years with poor set. In such years, the yields of these clones may be "normal" and could be used for red wine production. In years of good set, the heavy crop on these clones could be diverted to white or sparkling wine production.

Loose-clustered types available in the USA have come from Swiss clonal selection programs that screened clones for resistance to Botrytis. They have a longer pedicel and rachis than the other types, which results in a loose cluster. Berry size is large but color is good and wines made at OSU from these types have been distinctly aromatic. These clones have potential for red wine production, particularly as a blending component with other

types. They have potential for vineyards with Botrytis problems or for growers wishing to reduce fungicide use.

Most of the clones available in Oregon fall into the group of standard Pinot noir, often called Pinot fin. These clones have small, tight clusters, low yields, and a drooping plant habit. They can make intense red wines in Oregon and should be part of any Pinot planting intended for red wine production. Clones within this group clones may differ in yield, color, and maturity, although the differences within this group are not as large as the differences between this group and the other Pinot types. New clones now available from France and new trials at OSU and in commercial vineyards should more clearly define the differences within this large group of clones.

Clonal planting material originating from a certification program usually has been tested for the presence of grape viruses. Certified, virus tested clones offer growers some degree of assurance that the plant material will not have potentially damaging viruses. However, the virus status of a clone may not always be the same as tested certified stock. This is particularly true if the parent material has been grafted. A virus- free clone grafted to a virus-infected rootstock will become infected. Thus, any propagation wood taken from those vines in the future will also be virus-infected. While a clonal ID number will tell you the genetic origin of a vine, a certification tag is a better indication of a clone's viral status.

Pinot noir Clones Available to Oregon Growers

The following is a list of clones available to Oregon growers at the time of writing. This list will, no doubt, change with time. New clones from both Burgundy and Champagne are currently being tested for virus status in quarantine programs and may be available soon. Some other clones may be pulled from certification lists if routine virus screening finds

potentially damaging viruses. All of this material is either currently available from Oregon nurseries or available from certification programs in Oregon, California, or Canada. The descriptions provided are a brief summary only. They have been gleaned from several sources; however, information on many of the clones is scanty. New clonal evaluation programs in Oregon, California, and other states will provide much more information in the next ten years.

UCD 1 This is one of the "Jackson" clones. They are old selections from California that were planted in the University of California's Jackson Experiment Station. This clone was planted in an OSU clonal trial but an ID problem has "clouded" those results. Available from OSU.

UCD 1A A Swiss selection from Wadensvil (5306-2 sel. b111). This clone was not tested at OSU but it may be planted in Oregon. (see UCD 2A). Available from FPMS.

UCD 2A This is another Wadenswil selection (5306-2 sel b1 10/16). It is widely planted in Oregon. In OSU trials, it was a high quality clone with low to moderate yields, a prostrate growth habit, and average maturity. It is an excellent clone for high quality red wine. This clone is called the "Wadenswil" clone in Oregon but it is possible that some of the "Wadensvil" in Oregon is UCD 1A. UCD 30 is a heat treated version of this clone. Available from FPMS, OSU, or Oregon nurseries.

UCD 4 A French introduction from Pommard. This is the most widely planted Pinot noir clone in Oregon. Clone UCD 5 is a heat treated version of this clone. Together they are known as the "Pommard" clone. A high quality clone with

drooping plant habit, small clusters, low to moderate yields, and average maturity. Excellent for red wine production. Available from OSU or Oregon nurseries.

UCD 5 (See UCD 4)

UCD 9 A clone from the Jackson Vineyard. It has not been tested in a clonal trial and is not widely planted. Available from FPMS.

UCD 10 Possibly an introduction from Spain, sometimes known as the "Beba" clone. UCD 12 is a heat treated version of this clone. This is a Pinot fin type clone with small clusters and low to moderate yields. It had good potential for red wine production in OSU trials. Available from OSU.

UCD 12 (See UCD 10)

UCD 13 This clone was selected from a California vineyard. It is the most widely planted clone in California, where it is known as the "Martini" clone. It did not do well in an OSU trial (poor set and poor color), but it produces some excellent red wine in California. Available from FPMS and OSU.

UCD 15 This is another "Martini" clone. It has not been evaluated or widely planted. Available from FPMS.

UCD 16 A clone from the Jackson Vineyard. It has not been tested in a clonal trial and is not widely planted. Available from FPMS and OSU.

UCD 17 Imported from Switzerland in 1966 as PI 312435-C-1. This clone is called Mariafeld in Europe. Mariafeld clones were selected from a large-berried type of Pinot noir with loose clusters known as Großclevners. They have good color despite the large berries, and because of the loose clusters have a

significant degree of Botrytis resistance. Unfortunately, in OSU trials this clone was mixed with UCD 1 and UCD 29. Based on European results and a reevaluation of our results, it would appear that this clone has excellent potential for Oregon. (See UCD 29) Available from OSU.

UCD 19 A "Gamay Beaujolais" clone. (See UCD 22) Available from FPMS.

UCD 20 A "Gamay Beaujolais" clone. (See UCD 22) Available from FPMS.

UCD 22 This is the "Gamay Beaujolais" of California. It is widely planted in California and is the third most common clone in Oregon. It is not the Gamay that Beaujolais wine is made from. That variety is Gamay Noir à Jus Blanc. Clones UCD 19, 20, and 22 are upright clones of Pinot noir. UCD 22 is the most widely planted of the three. They have larger clusters and higher yields than standard Pinot fin clones. These clones make a good red wine in California but it is usually lighter in style than wines sold as Pinot noir. Available from FPMS, OSU, and Oregon nurseries.

UCD 23 This clone was imported along with UCD 17 from Wadensvil. In trials at Carneros Creek Winery it had the same loose cluster type and large berries as UCD 17. Available from FPMS and OSU.

UCD 29 This is one of the clones selected from the Jackson vineyard. In OSU trials it made excellent wine, but it was later learned that our test vines were a mix of a small tight-clustered type and a Mariafeld type. In the UCD Foundation Vineyard UCD 29 has a small tight cluster. Available from OSU.

UCD 30 This a heat treated version of UCD 2A. In trials at OSU this clone had larger clusters, poorer color, and lower sugar than UCD 2A. Available from FPMS.

UCD 31 (See ESP 236)

UCD 32 This is one of the most widely planted clones in Champagne. It has low to moderate yields in tests in Champagne with above average sugar, and some degree of Botrytis resistance. Available from FPMS.

COL 538 A small-clustered Pinot fin type. In OSU trials this clone had low yields and good color, sugar, and wine quality.

ESP 236 A very high yielding clone. In OSU trials this clone consistently had the highest yields. Used in Burgundy to normalize yields and in Champagne for sparkling wine. In Oregon it would only be acceptable for red wine production in low yield years, or if the crop were controlled by short spur pruning or cluster thinning. Clone UCD 31 is separate importation of clone 236. Available from OSU, Oregon nurseries, and from FPMS as UCD 31.

ESP 374 A very upright clone with high yields. Color and sugar were poor in OSU trials but the wines were aromatic with good varietal character. This clone may have better quality if crops are kept low. This is a French clone but no information on this clone is available from France.

DIJON 60 Selected in Echezeaux France. Little information is available on this clone. Apparently a good quality clone with moderately high production. Available from OSU and Oregon nurseries.

DIJON 113 A Pinot fin clone from Morey-Saint-Denis, France. Widely planted in Burgundy. Average vigor with average to below average yields. Set and yields are irregular. Above average sugar and average acidity. A good quality clone when yields are kept under control. Available from OSU and Oregon nurseries.

DIJON 115 A Pinot fin clone from Morey-Saint-Denis. Widely planted in Burgundy. High to average vigor, prostrate growth, average set, compact clusters and less than average yields. An early ripening clone with high quality and dependable yields. Available from OSU and Oregon nurseries.

DIJON 375 A highly fruitful clone selected in Saint-Denis de Vaux. Vigorous with moderately upright growth. Yields above average with average quality. Loss of quality at higher yields. Used in Burgundy to help normalize production in low yield years. Used in Champagne for sparkling wine production. Available from OSU and Oregon nurseries.

DIJON 10/18 A selection from the Jura. Little information available. Apparently a good quality clone with moderately high production. Available from OSU.

Q390-02 A selection from France introduced into Canada. No information available.

Q1043-07 (Hurliman 2/45) A Swiss selection introduced into Canada. No information available.

Q1267-06 (Spatburgunder CL 91) A German introduction into Canada.

Figure 1. Effects of five trellis systems on yield components of three varieties. Lewis-Brown Farm, 1990.

Figure 2. Pinot noir berry and must samples from five trellis systems. Lewis-Brown Farm, 1990.

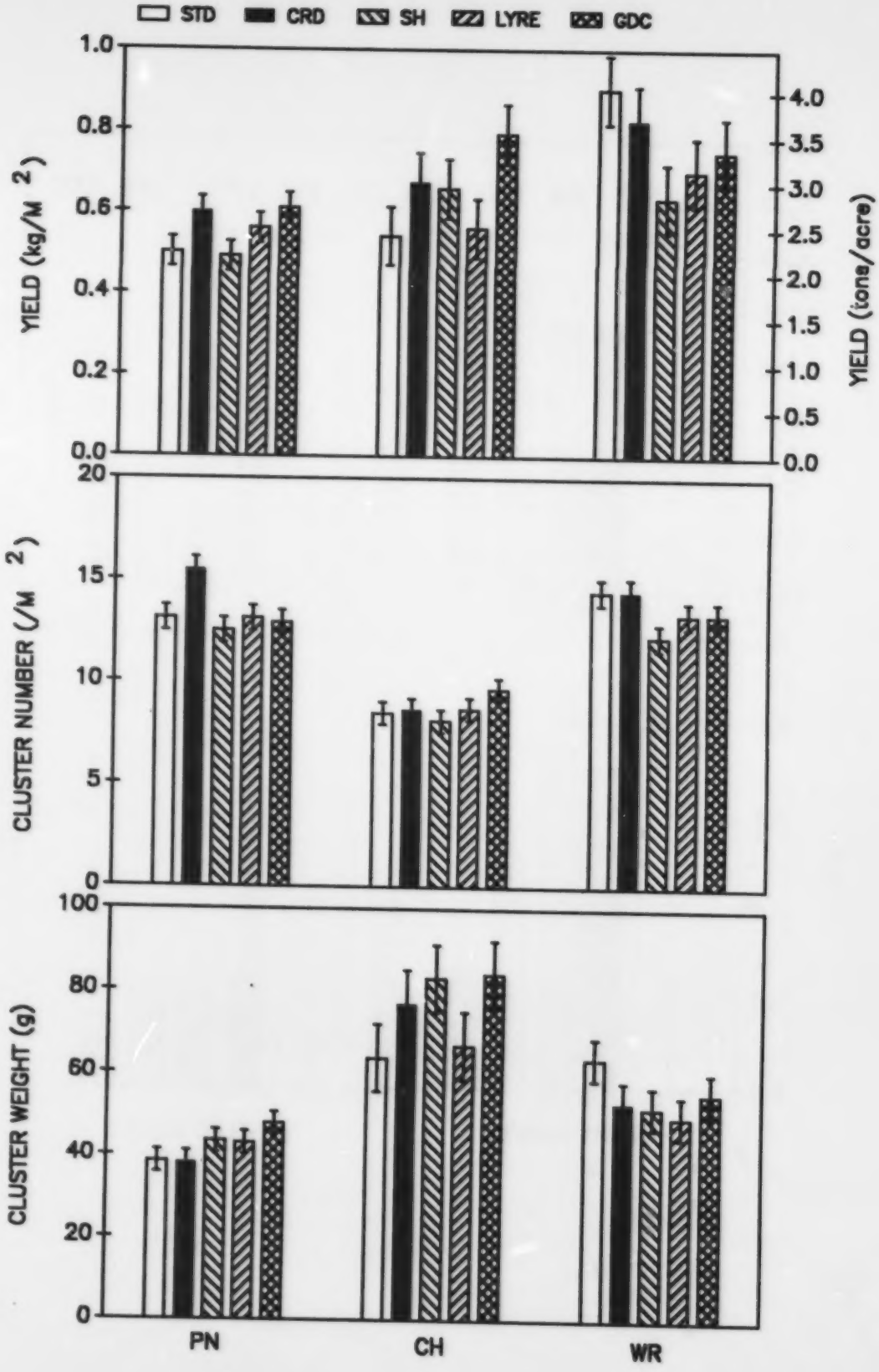
Figure 3. Chardonnay berry and must samples from five trellis systems. Lewis-Brown Farm, 1990.

Figure 4. Effects of shoot density and cluster thinning on Pinot noir sugar accumulation. Woodhall III Vineyard, 1989 (SH = Scott Henry trellis).

Figure 5. Effects of shoot density and cluster thinning on yield of Pinot noir. Woodhall III Vineyard, 1990 (SH = Scott Henry trellis).

Figure 6. Effects of shoot density and cluster thinning on sugar accumulation of Pinot noir. Woodhall III Vineyard, 1990 (SH = Scott Henry trellis).

Figure 7. Effects of the growth diversion pruning system on pruning weight of Pinot noir, Chardonnay, and Cabernet Sauvignon. Woodhall III Vineyard, 1987-1990.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CRD
SH
LYRE
GDC
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YIELD (tons/acre)
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0.8
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0.4
0.2
0.0
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
CLUSTER NUMBER (/M 2)
20
15
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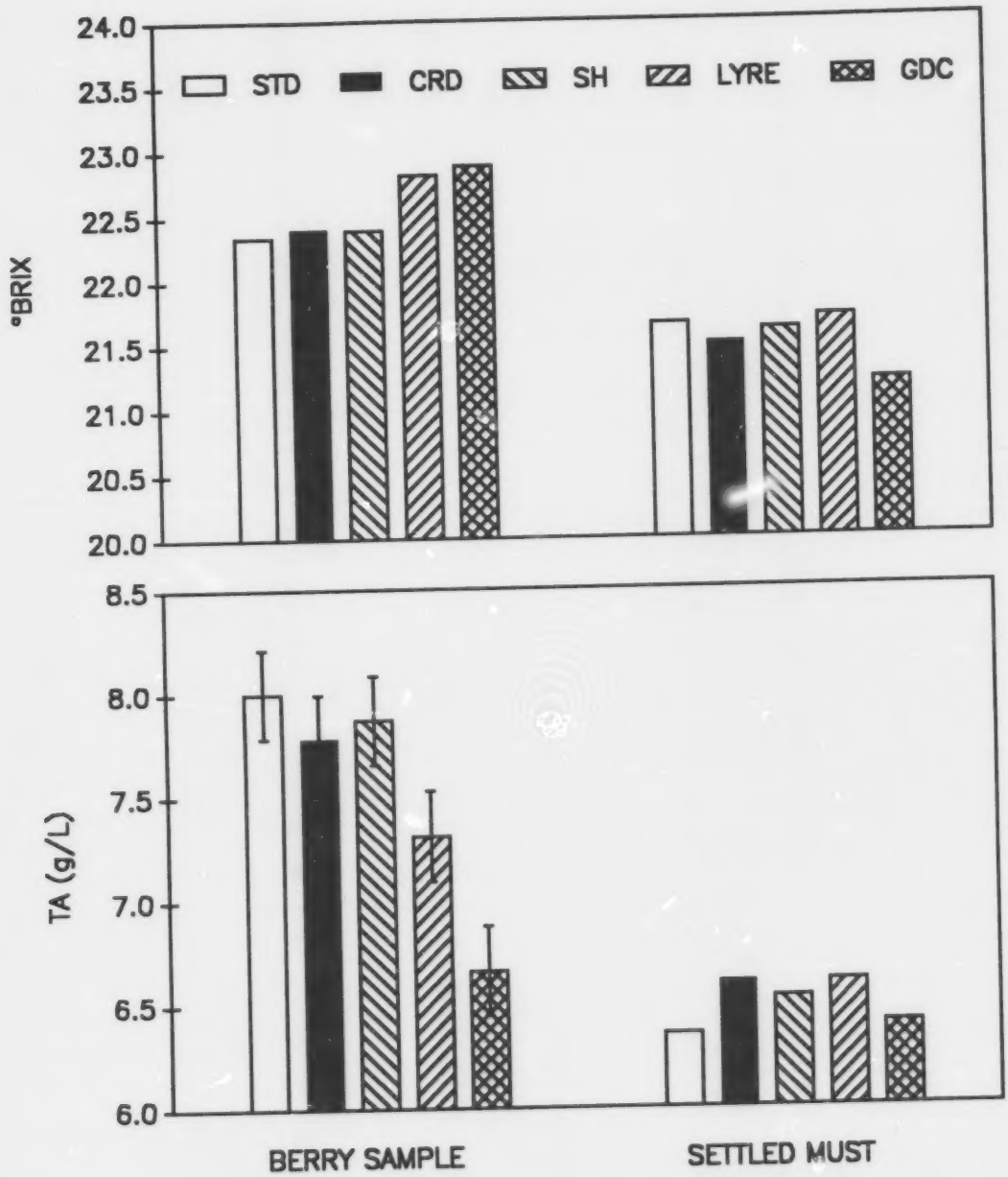
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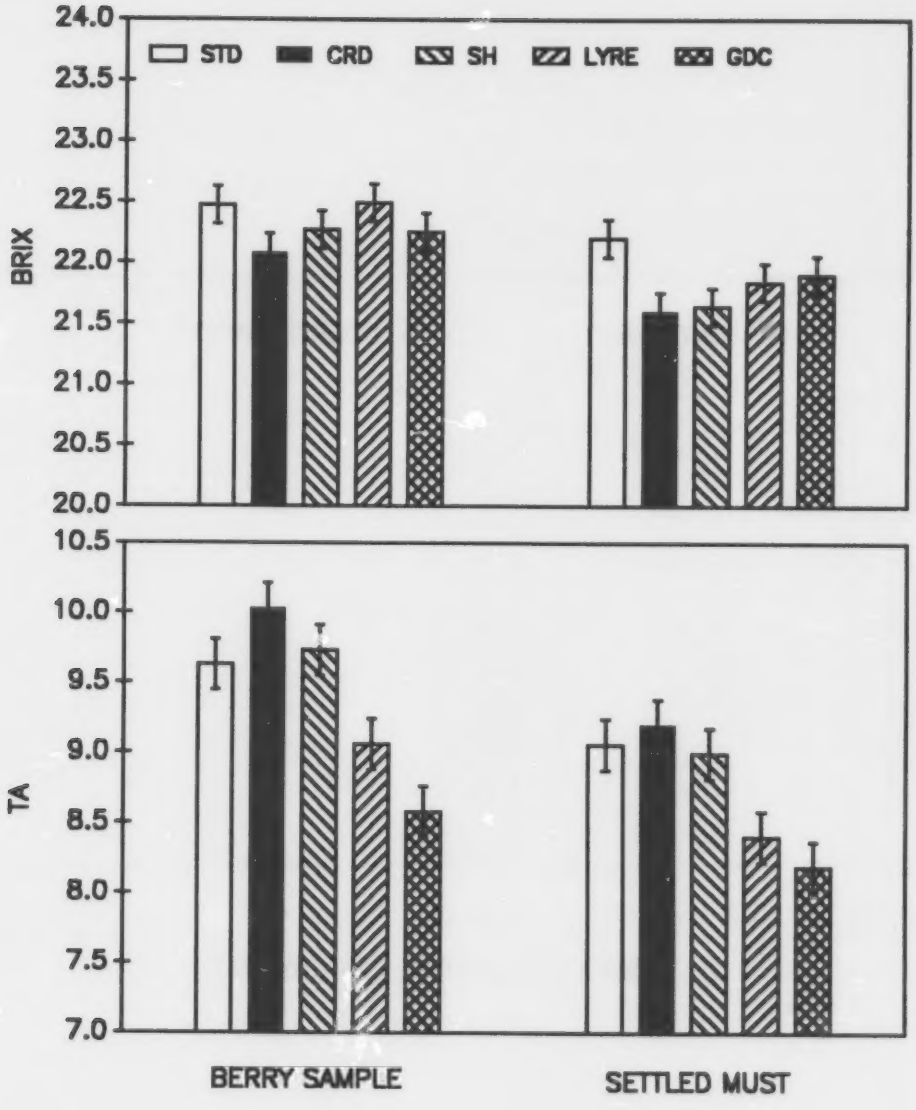
TA (g/L)
BERRY SAMPLE
SETTLED MUST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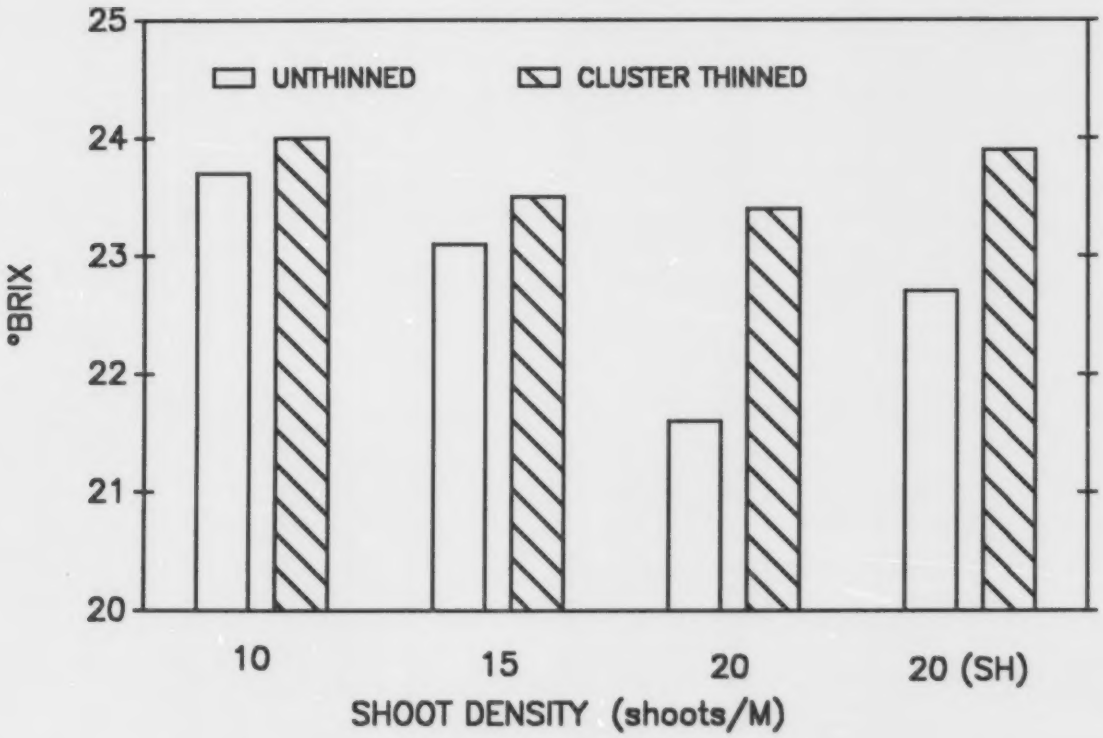
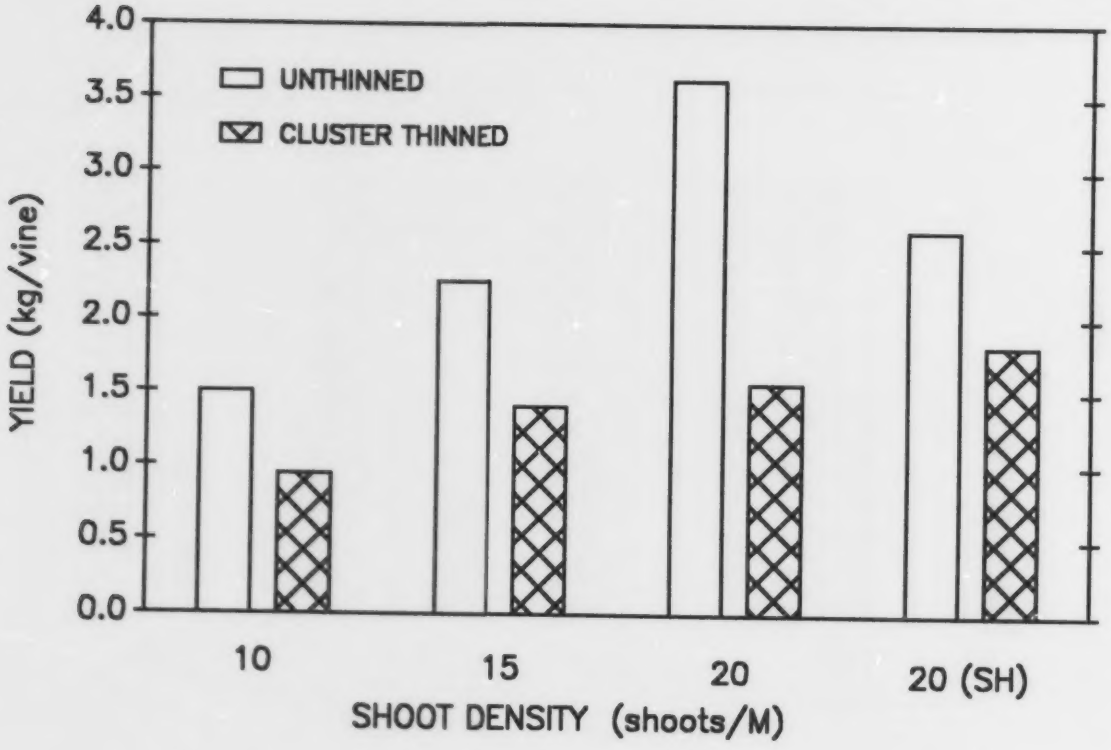
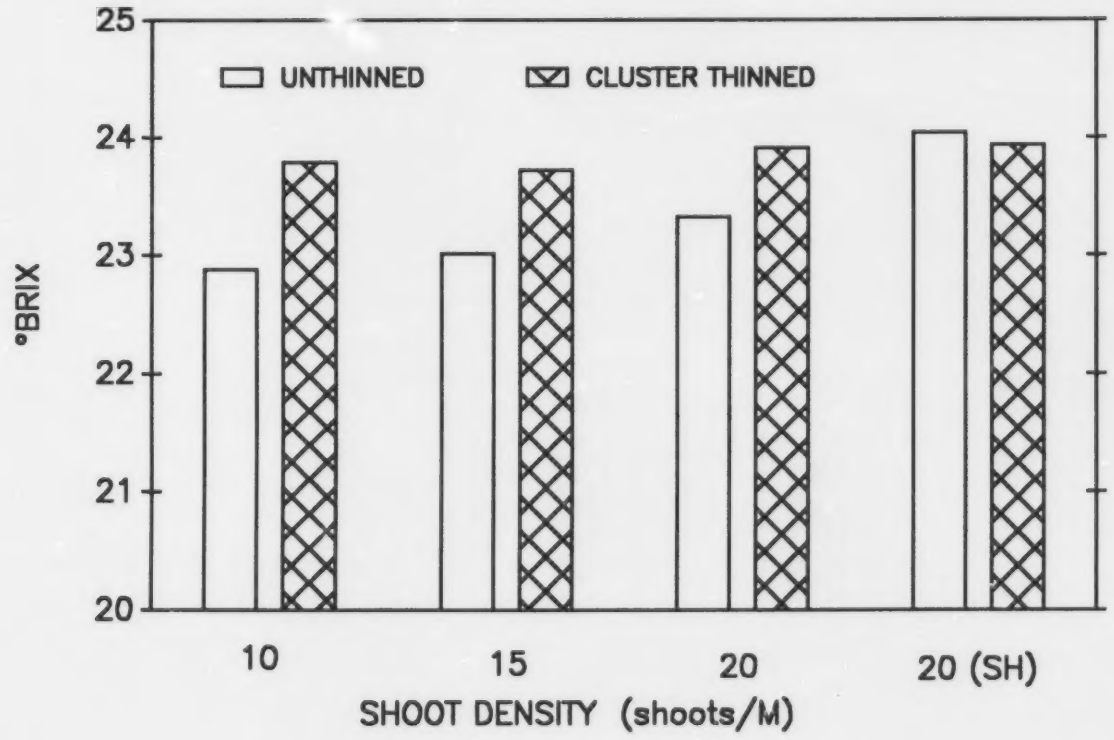

25
24
23
22
21
20
°BRIX
UNTHINNED
CLUSTER THINNED
10
15
20
20 (SH)
SHOOT DENSITY (shoots/M)


4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
UNTHINNED
CLUSTER THINNED
YIELD (kg/vine)
10
15
20
20 (SH)
SHOOT DENSITY (shoots/M)


25
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°BRIX
UNTHINNED
CLUSTER THINNED
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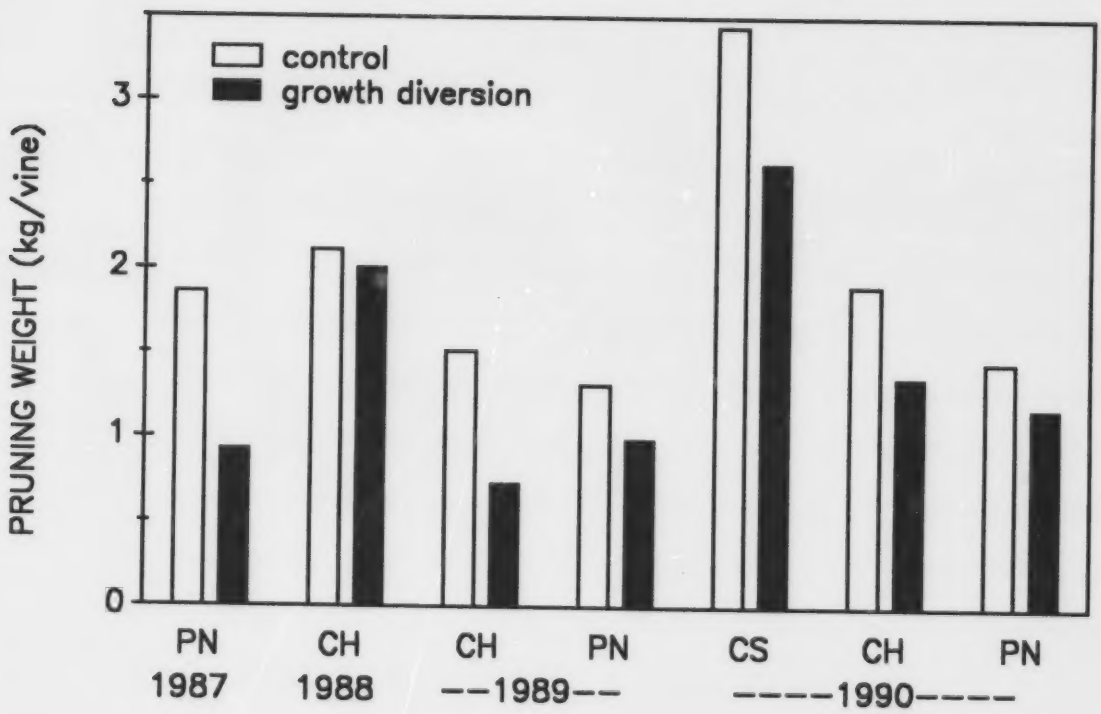
20 (SH)
SHOOT DENSITY (shoots/M)


control
growth diversion
PRUNING WEIGHT (kg/vine)
0
1
2
3
PN
1987
CH
1988
CH
PN
--1989--
CS
CH
PN
----1990----

Oregon Experiences with Malolactic Fermentations

By Barney Watson, Oregon State University

In Oregon red wines usually undergo a malolactic fermentation in the fall during or after yeast fermentation or the following spring when the cellars warm up. Many Chardonnay wines also undergo complete or partial malolactic fermentations. Without malolactic fermentations many of our wines would be unduly tart and acidic unless modified by other means such as by chemical deacidification. Malic acid content in Oregon Pinot noir and Chardonnay is often high at harvest comprising as much as 6 g/L and often 50% or more of the titratable acids present (Table 1).

Typically pH's at harvest are often very low (3.0 to 3.3) and malolactic fermentations often proceed slowly or are hard to induce, particularly in white wines such as Chardonnay. During the 1970's many Oregon wineries were having difficulty inducing the fermentations on a consistant basis, especially during cool harvest seasons in which the musts often had high titratable acidity and low pH. Most wineries did not have cellar procedures worked out to properly encourage malolactic fermentations and the commercially available malolactic strains at that time were not performing well (or consistantly) under Oregon winemaking conditions of low pH's and cool cellar temperatures. At that time we were relying primarily on the old workhorse ML-34 (California) but were having erratic results.

During the late 70's we began working with a few wineries which were having consistant malolactic fermentations in wines which had not been inoculated with commercial malolactic strains. These invariably were older established wineries which appeared to have developed populations of indigenous bacteria adapted to their cellar conditions. Working closely with two of these wineries, the Eyrie Vineyards in McMinnville and Knudsen-Erath

Vineyards in Dundee we isolated numerous strains of Leuconostoc oenos and screened them for growth and use under our winemaking conditions. This was a collaborative project between the Department of Food Science and Technology and the Microbiology Department at Oregon State University and involved isolation, characterization, experimental wine trials in our pilot plant winery, and finally numerous industry trials.

Two strains were selected which performed the best under Oregon conditions compared to the commercially available strains at that time. These were named Er1A and Ey2D, later also called OSU 1 and 2, respectively.

At low pH (3.0-3.3) malolactic fermentation were markedly affected by strain, and the time to complete the fermentation decreased as the pH increased: Ey2D and Er1A completed MLF much faster than ML-34, PSU-1, MLT (Swiss), BB 44-40 in Chardonnay with a pH 3.06 and in Pinot blanc with a pH 3.24. The wines were inoculated with 1% by volume actively fermenting starter cultures.

Er1A completed the fermentation within 80 days, and Ey2D within 125 days compared to 190 days for the other strains in the Chardonnay, and 25 and 60 days,respectively, compared to 110 days for most of the other strains in the Pinot blanc. The only strain that compared favorably to the Oregon strains in the Pinot blanc (pH3.24) was the the Swiss strain MLT (obtained from Microlife Technics in Florida).

At higher pH (3.4 or greater) the rate of fermentation was less affected by strain; all strains tested completed MLF in 25-30 days in Pinot Noir with an initial pH of 3.46. Overall, we found that ER1A and EY2D strains more pH tolerant than the other strains tested. ER1A

completerd MLF faster at low pH at temperatures greater than 15^{0}C, while Ey2D was more cold tolerant and completed MLF faster at temperatures of 15^0 C or lower.

MLF strains poorly adapted to very low pH had prolonged lag phases after inoculation prior to the onset of the malolactic fermentations compared to the Oregon strains. For example, in the Chardonnay with a starting pH of 3.06, both of the Oregon strains had a short lag phase and began MLF within 20 to 40 days after inoculation, compared to 60 days or longer for the other strains.

The reason for this was the superior conservation of cell viability by the Oregon strains in wines of low pH. After inoculating with on the order of 10^7 cells per mL the Oregon strains were able to maintain high cell densities while the other strains had considerable loss of cell viability due to the extremely low pH. We have observed as have other researchers that cell densities on the order of 10^6 to 10^7 are necessary in wines before any significant malolactic fermentation occurs. Malolactic bacteria which are poorly suited to the environmental conditions will have considerable decline in cell density and long lag phases before the fermentation is induced if at all (Figure 1).

Starter Culture Preparation

Our initial malolactic work was done in the late 70's and early 80's prior to widespread commercial use of freeze-dried concentrates available today for inoculating wines to very high cell densities.

At that time we developed procedures using liquid cultures which would successfully induce MLF in commercial Oregon wines using our new strains. Wines had to be inoculated with actively growing cultures at high cell densities in order to obtain timely MLF under Oregon conditions.

Starter cultures were prepared by first growing the bacteria to very high cell counts in a rich nutrient based media (MR-V8 broth). Sterile grape juice media (GJM) was inoculated with the MR-V8 cultures and incubated at 18°C for about 2 weeks. Winery starter cultures were then prepared by inoculating wines with 1- 2% by volume of actively fermenting GJM cultures during the early stages of yeast fermentation. After 1-2 weeks these winery starter cultures were then used to inoculate larger volumes of wine at 0.5 to 2 % by volume (Table 2).

In practice, commercial juice and fermenting wines were found to have natural background counts (cfu/mL) of viable lactic acid bacteria of from 0 to 10^4 cells per mL. The pure GJM cultures used to inoculate industry starter cultures generally contained on the order of 10^9 cells per mL, and commercial wines inoculated with up to 1-2% by volume with the GJM cultures had populations on the order of 10^7 to 10^8 after two weeks. The winery starter cultures were often prepared in 50 gallon lots and larger volumes of were then inoculated with these starter cultures. Large volumes of wines inoculated in this step by step manner were often finished with malolactic fermentation by the end of the alcoholic fermentation or shortly thereafter (Table 3).

Inoculation of wines during the early stages of fermentation usually had the best success for inducing malolactic fermentations under our conditions and we have observed no problems with concurrent growth of yeasts and our Leuconostoc strains in the presence of sugars during fermentation.

The Oregon strains Ey2D and Er1A were patented by OSU in 1985 and have subsequently been produced as liquid cultures for our industry's use by a laboratory in Oregon (Wyeast Labs, Hood River). We are currently negociating with Lallemand (Lalvin) for the patent rights to produce freeze-dried concentrates of Ey2D and Er1A to be marketed this fall by Scott Labs.

Prevention of Lactic Acid Bacteria Spoilage

Growth of undesirable lactic acid bacteria (LAB) can occur both during and after a desirable malolactic fermentation. 'Off' characteristics can include loss of fruitiness, production of excess diacetyl (buttery aroma), acetic acid, acrolein (bitter flavor), mousy odors, and occasionally the production of oily and ropy character. The wines may also become flat, cloudy, and gassy.

Leuconostoc oenos sp. usually predominate at lower pH's. Because of the naturally low pH's of Oregon fruit at harvest, clean and desirable malolactic fermentations by Leuconostoc sp. are generally the rule.

The pH of wines after completion of the fermentation, however, are often 3.6 or higher especially in warmer, riper harvest seasons of which we have had several since the mid 80's.

For a number of years now the winemaking trends in Oregon have shifted toward minimal processing with the idea of maximizing wine quality, particularly with Pinot noir. Winemakers are using less or no SO2 during processing and are using minimal filtration or bottling wine with no filtration at all.

More and more frequently we are seeing examples of secondary lactic acid bacteria growth usually by Pediococcus sp. often following completion of a normal malolactic fermentation. Invariably the problem wines have had little or no SO2 added and are unfiltered. Usually the pH values are greater than 3.6.

A microscopic survey in 1990 of several barrels of young Pinot noir in one Oregon winery revealed a typical pattern of how the ratios of lactic acid bacteria species can vary with pH. Wine with a pH of 3.35 contained only Leuconostoc oenos. Wine with a pH of 3.47 contained predominantly L. oenos with some Pediococcus sp. present. Wine with a pH of 3.70 contained mostly L. oenos with many Pediococcus sp. present, and wine with a pH of 3.85 had populations of Pediococcus sp. equally as abundant as L. oenos. Several of the barrels with the higher pH's also began exhibiting an oily, ropy character towards the end of a normal malolactic fermentation (Table 4).

Pediococcus damnosus was isolated from the higher pH wines from this winery and a strain of Leuconostoc sp. was also isolated which produced polysaccharide dextran type colloidal material causing the wine to have a ropy character. The wines were racked from the barrels and 25 ppm of SO2 was added along with a tartaric acid addition to lower the pH to below 3.6. The wines were rough filtered and returned to the barrels for aging after

the barrels were cleaned and sulfured. The ropy character disappeared upon pumping due to the shearing action on the dextrtan polymers. The wines were monitored closely thereafter and no spoilage character reoccurred.

In recent years the addition of tartaric acid to musts or new wines to lower the pH is a common practice in Oregon. Additions of 0.5 to 1.0 grams per liter often are sufficient to buffer the pH to desired levels of 3.6 or below. Lowering the pH, however, does not exclusively select for Leuconostoc sp.over say Pediococcus. sp. If the pH is low, Leuconostoc sp. invariably dominate although small populations of Pediococcus sp. are commonly observed at pH's as low as about 3.4. At high pH's above 3.6, however, large populations of Pediococcus sp. can develop either during or after a normal malolactic fermentation and can cause off spoilage character if left unchecked.

Even when musts and wines are inoculated with a high density of pure malolactic bacteria, large populations of indigenous lactic acid bacteria are often present even though they may be outnumbered by the added culture. By the end of yeast fermentation indigenous bacteria have often grown to high cell densities even though little or no malic acid may have been degraded yet, this is particularly true when no SO2 has been added at crushing. Inoculation with a pure culture at this stage does not insure a 'pure' culture fermentation by any means.

It is very important to monitor musts and wines frequently with a microscope during processing to assess the type and relative proportions of lactic acid bacteria species present. Where possible samples should be plated in a dilution series to determine the cell densities as well.

Controlling Malolactic Fermentation with Nisin Resistant Strains of Leuconostoc oenos

Since 1988 my colleague Mark Daeschel and I have been developing a natural biological process to insure both a pure culture malolactic fermentation with a desirable strain of malolactic bacteria and to insure that no undesirable or spoilage lactic acid bacteria can grow either during or after the malolactic fermentation.

This process involves the use of nisin and nisin resistant strains of Leuconostoc oenos. This work was funded by the Oregon State University Agricultural Research Foundation, and the Technology Transfer Office, and more recently by the Oregon Wine Advisory Board.

Nisin is a natural compound produced by the dairy bacteria Streptococcus lactis. It is member of a family of compounds known as bacteriocins which are produced by some bacteria and inhibit the growth of other bacteria. Nisin is active against gram-positive bacteria and their spores which includes all lactic acid bacteria found in wines but not Acetobacter. Nisin binds to the cell walls of the bacteria and disrupts the cell membrane killing the cells. It has no effect on yeasts or any other organisms except gram-positive bacteria.

Nisin has been used in the food industry in Europe for 25 years and is now on the GRAS list (generally regarded as safe) as a food additive in the US. It is currently approved for use in certain dairy products and is currently being used commercially in a cheese spread to inhibit Clostridia botulinim. Nisin is a cycic polypeptide with a MW of 3500 daltons. It is

stable to both low pH and to heat. Nisin is positivley charged and readily binds to negatively charged particles. In some food systems it binds to fats and other proteins which can reduce its effectivess.

Nisin has no known toxicity and is readily degraded by digestive enzymes such as chymotrypsin. It is active against gram-positive bacteria at concentrations as low as 25 ppm (100 U/mL). Wine is an ideal environment for nisin because it is stable at low pH, gram-positive bacteria such as lactic acid bacteria are the target, and wine is a fluid system which generally lacks interfering substances which can inactivate it.

A plating technique was developed to assay for nisin activity in wines. Agar plates are poured and impregnated with a bacteria strain which is very sensitive to nisin. Small wells are then made in the plates and wine samples are added. Zones of growth inhibition occur when nisin is present and the diameter of the zones can be related to nisin activity. Nisin activity in Pinot noir and Chardonnay four months after addition of 25 ppm (100U/mL) is shown in Figure 2.

The plate on the left is the red wine. The center well (1) contains a standard of 25 ppm of nisin. The surrounding wells contain wine samples. Zones of inhibition are clearly visable around each sample indicating nisin activity although they are much smaller than the control. We have observed that nisin activity in red wines decreases over time possibly due to binding to phenolic material. Biologically active levels were still present, however, even after four months.

The plate on the right contains the nisin standard in the center surrounded by Chardonnay

wine samples. Note that in white wine there is no apparent loss of nisin activity even after four months.

Nisin can also be removed from wines if desired by certain positively charged fining agents. We found, for example, that bentonite fining at the equivalent of 3# per 1000 gallons could completely remove or significantly reduce nisin activity.

We tested the inhibitory effect of nisin on the growth of Leuconostoc oenos and malolactic fermentation on non-sterile new wines. We inoculated wines with Er1A and Ey2D with and without 100 U/mL of nisin. The initial cell density at inoculation was on the order of 10^6 cells per mL. At 28 and 56 days the inoculated wines containing nisin contained no detectable viable cells and no malic acid was degraded (mg/ml). The inoculated wines with no nisin added had completed malolactic fermentation within this time (Table 5).

Nisin can be added at crushing or during fermentation to insure no lactic acid bacterial growth. The malolactic fermentation can then be controlled by inoculating with a nisin-resistant malolactic bacteria strain. In this way the malolactic fermentation can be carried out by a pure culture in a controlled manner at any point in the winemaking process that the winemaker desires.

In our laboratory we developed nisin resistant strains of both our Oregon malolactic bacteria Ey2D and Er1A by challenging them first with very low and then increasing concentrations of nisin until variants were selected which were resistant to 25 ppm or 100 U/mL of nisin.

Wine inoculated with Pediococcus sp. with no nisin present contained relatively high cell counts after 3 months and the malic acid was partially degraded. With the addition of 100 U/mL of nisin no cells were present and malic acid was not degraded after 3 months. We isolated this particular strain of Pediococcus from an Oregon Pinot noir which had obvious lactic acid bacteria spoilage character (excessive buttery diacetyl and lack of fruitiness).

Wine inoclated with both the Pediococcus and the nisin-resistant Leuconostoc strain (Ey2D-R) had high cell densities of both species after 3 months and the malolactic fermentation was complete presumably through the action of both types of bacteria. The addition of nisin to this system completely killed the Pediococcus bacteria while the nisin resistant Leuconostoc strain completed the malolactic fermentation as a pure culture fermentation (Table 6).

This last fall we demonstrated our process in experimental winery trials at OSU with replicated lots of Pinot noir. We inoculated new wines with Ey2D-sensitive and Ey2D-resistant strains with and without the addition of 100 U/mL of nisin. Two base wine lots were used: one with no SO2 added and one with 50 ppm added at crushing (Table 7).

Controls with no inoculum and no nisin added eventually underwent malolactic fermentation with or without SO2 addition but the fermentations were delayed. Wines inoculated with the Ey2D sensitive strain and the Ey2D resistant strains completed malolactic fermentation within three weeks. Uninoculated wines with nisin added had no viable lactic acid bacteria present after 2 months whether or not SO2 was added. At least with respect to control of lactic acid bacteria in wine The use of nisin and nisin resistant strains to induce malolactic fermentation may reduce or eliminate the use of SO2 for

controlling lactic acid bacteria in wine.

The Ey2D nisin resistant malolactic strain is low pH and low temperature tolerant and when used with addition of nisin to wine will insure a pure culture fermentation. The timing of MLF is also completely controllable, for example is a winemaker wants the MLF to occur after fermentation in the barrel the wine can be inoculated then and an early addition of nisin will insure all indigenous LAB in the wine will be prevented from growing.

We believe that this new technology may help improve wine quality and stability especially where minimal processing is desired in order to maximize wine character and complexity.

Table 1. Typical Composition of Oregon Wines Before and After Malolactic Fermentation

	Before MLF				After MLF		
Variety	°Brix	TA g/L	Mal. g/L	pH	TA g/L	Mal. g/L	pH
CH	22.3	9.0	6.0	3.34	4.7	< 0.05	3.74
CH	21.2	11.0	6.9	3.16	5.9	< 0.05	3.50
PN	22.0	9.8	5.5	3.40	5.5	0.11	3.96
PN	21.0	11.5	5.7	3.10	5.7	0.05	3.84

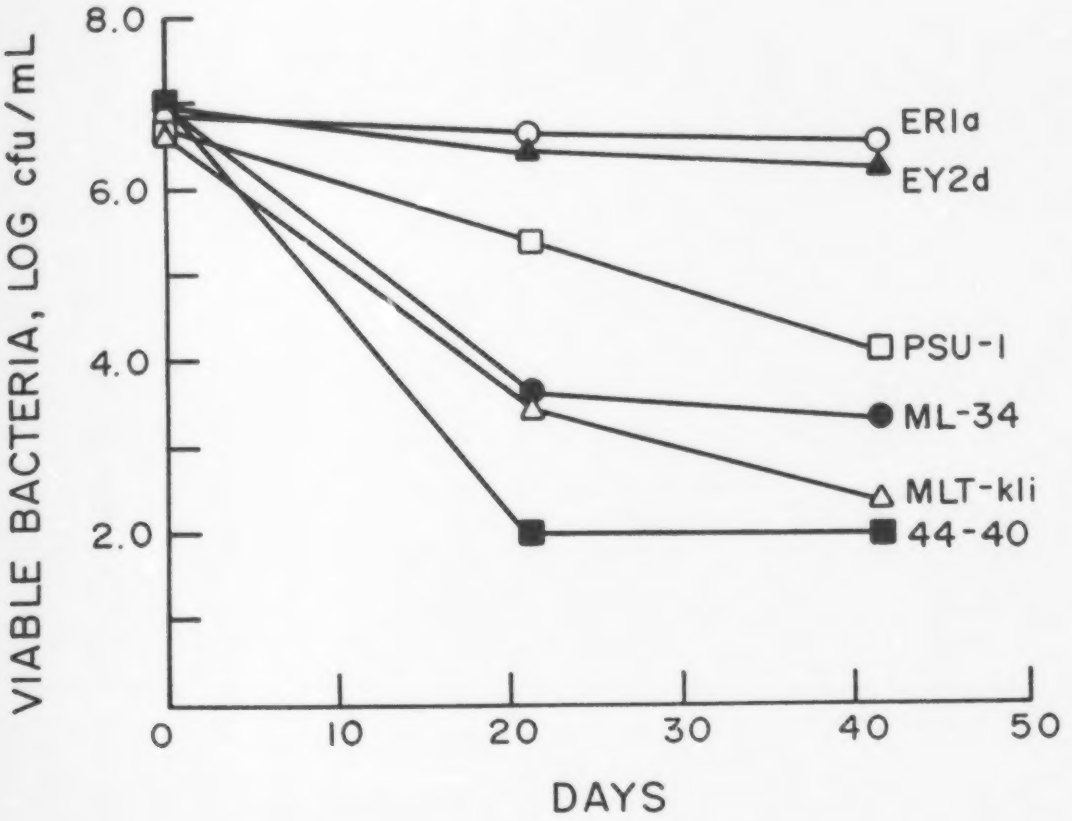


Fig. 1. Viable bacteria in Chardonnay[1] after inoculation.

[1]Wine composition at inoculation: alcohol 9.4%, pH 3.06, TA 11.1 g/L, free SO_2 8 mg/L, total SO_2 13 mg/L.

Table 2.

Starter Culture Preparation

1. Pure cultures of Eria and Ey2d multiplied in nutrient broth (MR-V8) at 26°C for 1 week.

2. Grape Juice Media (GJM) inoculated with pure culture and incubated at 26°C for 2 weeks (Juice + water, 1:1; .05% yeast extract, pH 3.6)

3. Fermenting wines inoculated with 2% V/V GJM starter (1 gal. in 100 gals.)

Table 3. PERFORMANCE OF WINERY MALOLACTIC STARTERS

	VIABLE ML BACTERIA (CFU/ML)
NATURAL BACKGROUND IN JUICE AND WINES PRIOR TO INOCULATION WITH PURE CULTURES	$\emptyset - 10^4$
PURE CULTURES (GJM) USED 2% V/V TO INOCULATE WINERY STARTERS	10^9
WINERY STARTERS AFTER AVERAGE OF TWO WEEKS FERMENTATION AT T^o 60-65°F (AVE. YEAST POPULATION 10^8 CFU/ML) USED TO INOCULATE LARGER VOLUMES OF FERMENTING WINE 2% V/V	$10^7 - 10^8$

Table 4. Effect of pH on Lactic Acid Bacteria during Malolactic Fermentation

Wine	pH	Microscopic Observation
A	3.35	Exclusively L. oenos, no Ped. sp. visible
B	3.47	Predominantly L. oenos, few Ped. sp. present
C	3.70	Mostly L. oenos, many Ped. sp. present
D	3.85	Ped. sp. equally abundant as L. oenos

TABLE 5. Inhibitory effect of nisin (100 U/ml) on the growth of *L. oenos* and malolactic fermentation in nonsterile new Pinot noir wine

Treatment of wine[a]	CFU of LAB per ml (mg of malic acid remaining per ml) on the following day after treatment:		
	0	28	56
L. oenos Er1a	1.1×10^6 (3.7)	2.5×10^4 (2.5)	6.4×10^6 (<0.1)
L. oenos Er1a, nisin	1.1×10^6 (3.7)	<10 (4.1)	<10 (3.6)
L. oenos Ey2d	1.1×10^6 (3.7)	3.4×10^4 (3.2)	1.0×10^7 (<0.1)
L. oenos Ey2d, nisin	1.1×10^6 (3.7)	<10 (3.9)	<10 (3.4)
Nisin	<10 (3.7)	<10 (4.0)	<10 (3.8)
No addition[b]	<10 (3.7)	<10 (ND[c])	<10 (3.8)

[a] The initial inoculum was approximately 1.1×10^6 CFU of *L. oenos* Er1a or Ey2d per ml.
[b] LAB were detected (>10^5 CFU/ml) after 5 months.
[c] ND, Not determined.

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TABLE 6. Inhibitory effect of nisin on *P. damnosus*, nisin-resistant *L. oenos* Ey2d-NR1, and nisin-sensitive *L. oenos* Ey2d and MLF[a]

Treatment		Bacteria (CFU/ml)		Malic acid (mg/ml)
Bacteria added	Nisin added	*P. damnosus*	*L. oenos*	
1. None	No	<10	<10	3.5
2. *P. damnosus*	No	1.6×10^4	<10	1.7
3. *P. damnosus*	Yes	<10	<10	3.7
4. *P. damnosus*, *L. oenos* NR1	No	9.0×10^5	5.2×10^7	<0.1
5. *P. damnosus*, *L. oenos* NR1	Yes	<10	9.3×10^7	<0.1
6. *P. damnosus*, *L. oenos*	No	1.3×10^6	8.4×10^7	<0.1
7. *P. damnosus*, *L. oenos*	Yes	<10	<10	3.2
8. *L. oenos* Ey2d-NR1	No	<10	1.4×10^7	<0.1
9. *L. oenos* Ey2d-NR1	Yes	<10	6.8×10^6	0.2
10. *L. oenos* Ey2d	No	<10	7.8×10^7	0.3
11. *L. oenos* Ey2d	Yes	<10	<10	3.5

[a] Nisin (100 U/ml) was added to sterile new Pinot noir wine, which was held at 18°C for 3 months.

Daeschel et. al. Applied and Environmental Micro., February 1991, p. 601-603.

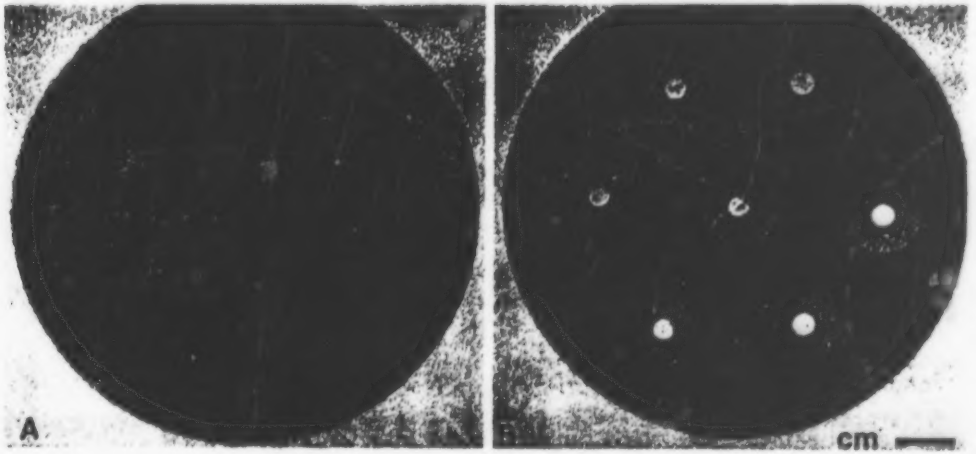

FIG. 2. Residual nisin activity (initial nisin concentration, 100 U/ml) in Pinot noir (A) and Chardonnay (B) after 4 months of storage. Treatments: 1, control (nisin added to wine just before assay); 2 and 3, *L. oenos* Ey2d cells added; 4 and 5, *L. oenos* Er1a cells added; 6 and 7, no cells added.

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Table 7.

1990 Experimental Winery Trial
Pinot Noir

Lot	mg/L SO_2 addition	units Nisin addition	strain MLB inoculum	MLF response
1,2	+50	+100	Ey2d-Res	Induced
3,4	+50	+100	No Inoc.	Suppressed
5,6	+50	0	Ey2d-Sens.	Induced
7,8	+50	0	No Inoc.	Suppressed (Delayed)
9,10	0	+100	Ey2d-Res	Induced
11,12	0	+100	No Inoc.	Suppressed
13,14	0	0	Ey2d-Sens.	Induced
15,16	0	0	No Inoc.	Delayed

CONTOUR MAPPING OF VINEYARD VARIABLES

Contour mapping of vineyard variables such as soluble solids, total acid and ph may be possible with the use of technology borrowed from the mining industry. Computer programs using geostatistical techniques will be tested during the 1991 season to determine their accuracy and usefulness for assessing viticultural practices and selective harvesting. The purpose of this presentation is provide food for thought with respect to sampling problems and maturity assessment.

In my vineyard I have, within a single vineyard block, a variety of slopes, facing all points of the compass, and a variety of soil types, from clay to rocks and sand. In one area I have Pinot Noir planted in clay on a north slope and in sand and rocks on a south slope. My concern is that there will be a substantial difference in the rates of maturity under these conditions and to obtain the best fruit quality it will be necessary to treat this area as two separate blocks when sampling and harvesting. Conventional sampling techniques do not address the problem of where the dividing line should be.

The apparent solution would be to make a map of the vineyard layout and select sample locations at regular intervals. Then walk through the vineyard with a refractometer, taking a reading from a single berry at each sample location, and contour the results.(fig 1) This should outline the areas of greater or lesser maturity. Unfortunately this doesn't work because there is too much variation between the berries in any given area. In fact, a single berry is not representative of a cluster, let alone the vine or group of vines it is supposed to represent. Figure 2 shows some single berry samples of partially shaded fruit taken from gewurztraminer vines in a small area. The distribution of these berries is such that if you were to select a single berry from this area, there is only a 65% chance it will be within 1.9 brix of the true average of the area. The result is that the contours in figure 1 represent the variation of the berries, not the trends of maturity that we were after.

The mining industry faces the same problems and has developed a field of study to deal with it. Geostatistics is designed to handle the problem of highly variable data.

GEOSTATISTICS

Geostatistics is a set of tools to deal with spatially correlated data such as soluble solids in the vineyard.

Classical statistics, unlike geostatistics, assumes that there is no relationship between samples and that they are each independent and random. Conventional vineyard sampling techniques use this approach. In geostatistics, it is assumed that there is a relationship between samples. For example, if several samples from one area are found to have an average brix

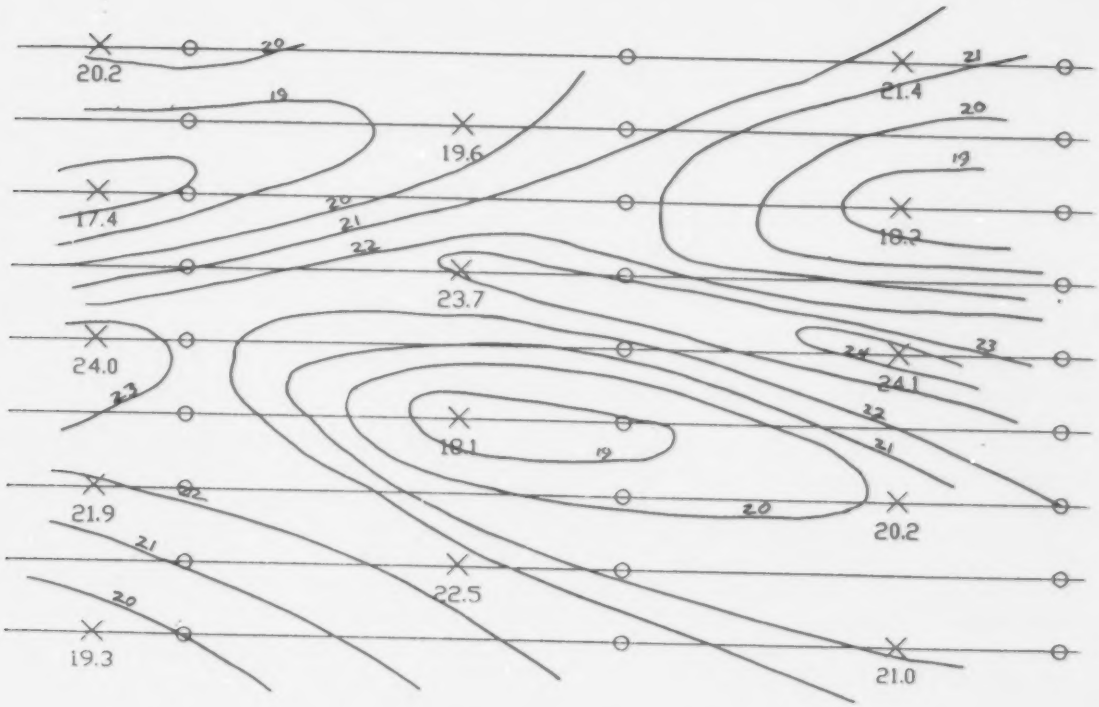

Fig. 1 Vineyard maturity data (brix) contoured using conventional techniques.

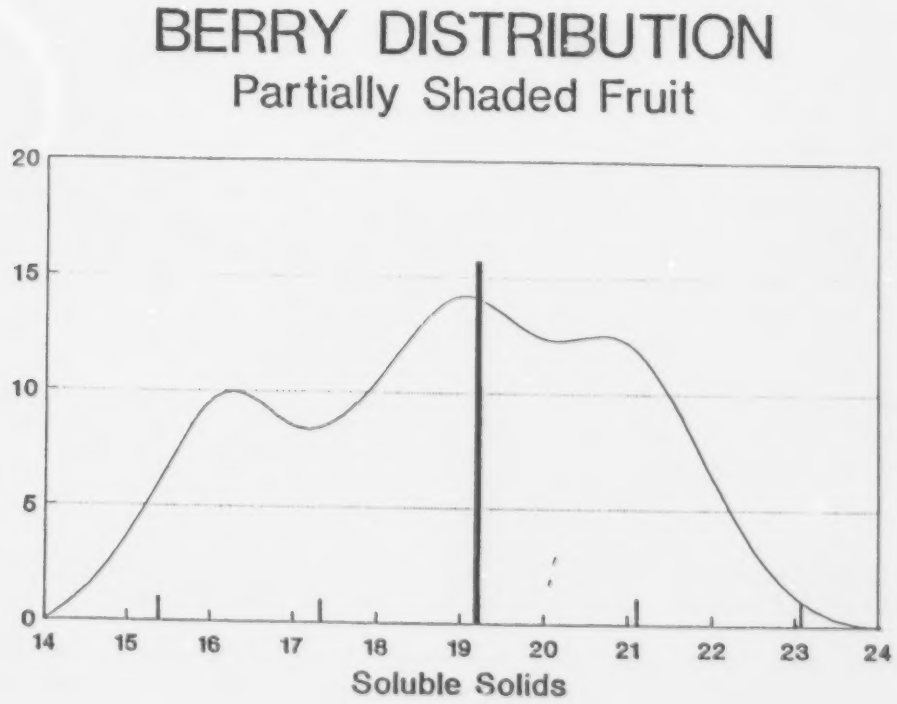

Fig 2. Distribution of partially shaded gewurztraminer berries from a small area. Mean is 19.2 brix.

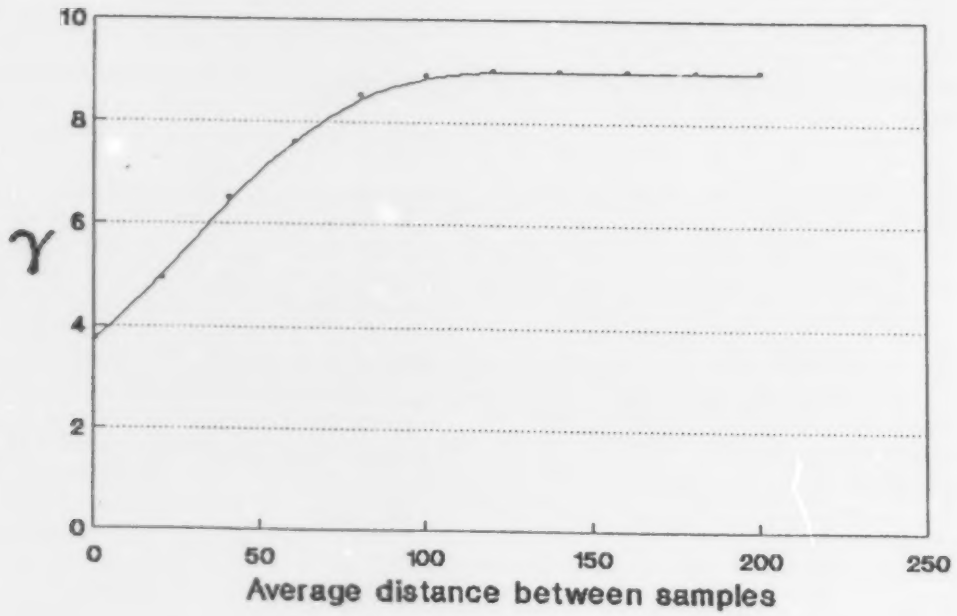

Fig. 3 Variogram graph showing variation between samples as a function of distance. The greater the distance between samples, the less the correlation.

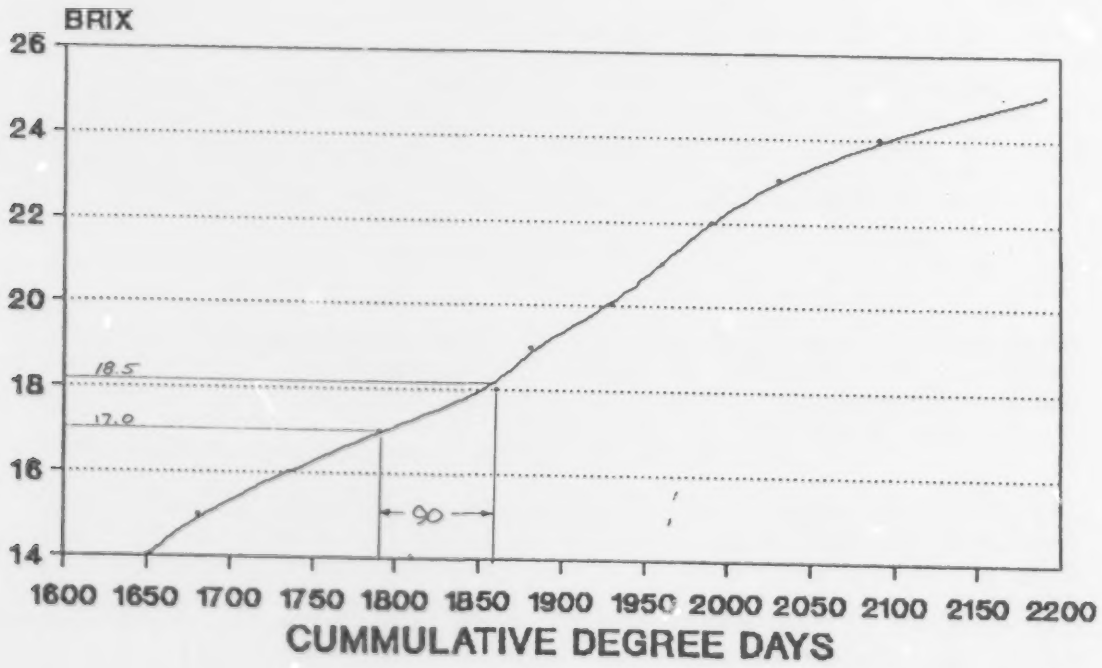

Fig 5. Graphical method of predicting a new brix reading from a previous reading and recorded weather data.

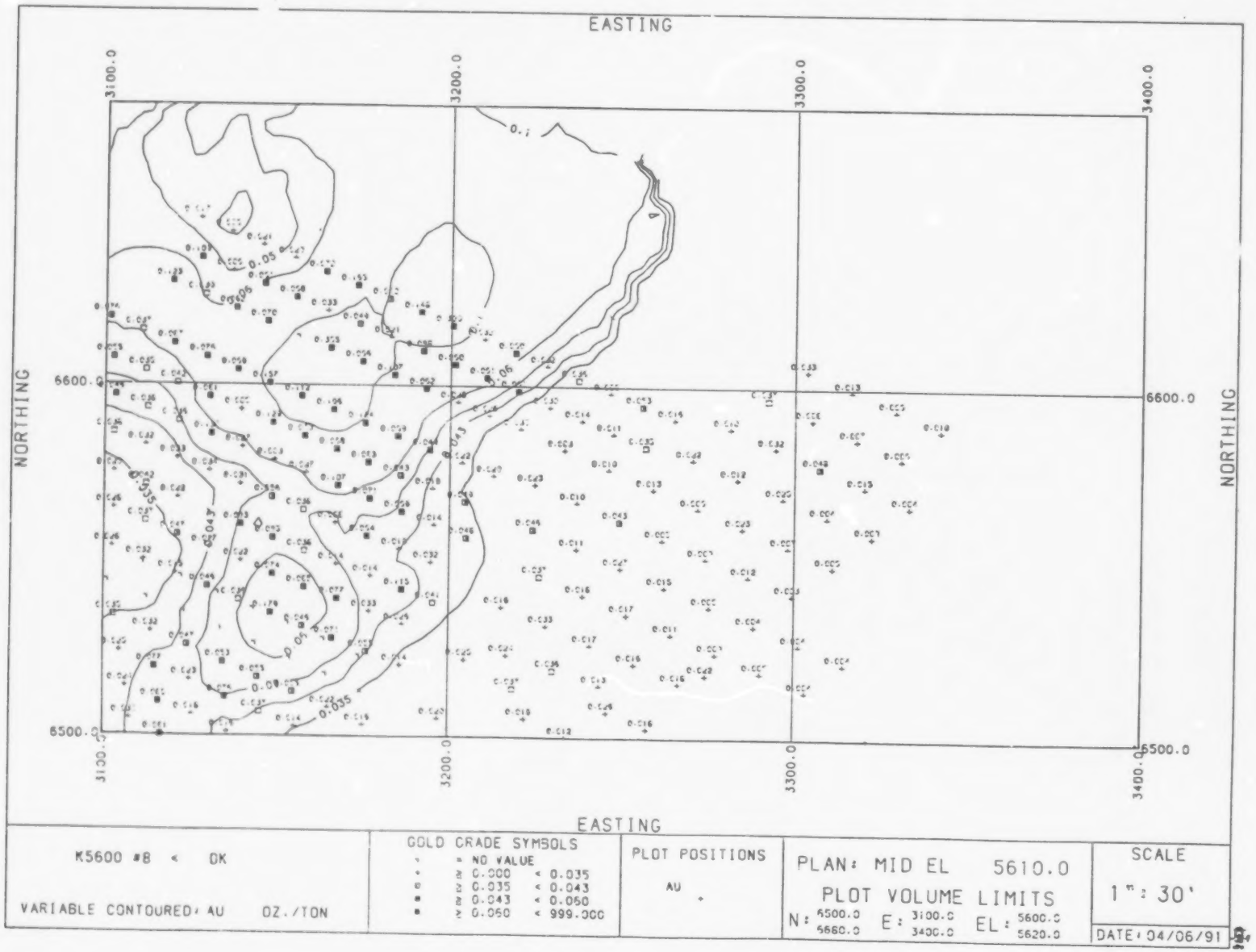

Fig. 4 Plot of mining samples showing highly variable nature. Numbers are original samples, contours are from kriged estimates.

of 24, it would be expected that another sample, taken in that area, would have a similar value. Two basic tools used in geostatistics are the variogram and kriging.

A variogram is used to determine the relationship between the samples. The computer will analyze all of the samples pairs and produce a graph of variation vs distance. (figure 3) This graph represents the spatial correlation between the samples that is used in the kriging process.

Kriging predicts a whole new set of values, closely spaced, using the original samples and the relationship determined by the variogram. To calculate each prediction, the computer uses all of the surrounding samples and calculates a weighted average, using the spatial correlation to determine the weighting applied to each sample. The closer the sample, the greater the its effect on the predicted value. Typically, over 100 samples are used in the calculation of each value, so that the result is more representative of that area than an individual sample.

Once the kriging is done, the original samples are ignored and the predicted values are contoured. Since vineyard trials have not yet been done, figure 4 is an example of some mining data. The individual numbers are original samples, but the contour lines are from the estimated values. This example demonstrates how highs and lows of individual samples are ignored and only the trends are contoured.

The next step in this example would be to outline the area of interest and have the computer output the tonnage in that area and the average grade. This would work well for grapes as well as mining. If the tonnage of the outlined area is too much or not enough, adjust the outline and rerun the tonnage and brix calculation.

POTENTIAL USES

Most of the potential uses of contour mapping revolve around obtaining better information from the vineyard and improving control over what is sent to the crusher. These applications fall into the categories of adjusting viticultural practices, selective harvesting and prediction of maturity.

At present, adjusting vineyard practices means changing the treatment of an entire vineyard or block. Using contour mapping, it would be possible to restrict extra or altered treatments such as leaf removal, crop load adjustments and extra sprays to problem areas. The result would be savings in labour and materials. All examples to this point have shown only brix contours, but it would also be possible to contour total acid, ph, colour, phenols, monoterpines, soil moisture, incidence of disease, winter damage, tissue analysis etc. This would allow

the grower to check for a wide variety of problems and imbalances in maturity and adjust treatments as required.

Contour mapping would be ideal for selective harvesting practices. The vineyard could be sampled well before harvest time, and divided in subblocks based on the contours. These subblocks could then be sampled with conventional samples until harvest time and picked as they mature. The contours could also be used to select grapes with different characteristics for particular wines or to match areas from different vineyards to get the desired numbers. In order to compare maps from different vineyards, it is necessary to either sample them all on the same day or calculate what the values would be on a later day.

Values of brix, ph and total acid may be estimated by utilizing the historic maturity data from the vineyard and information available from Environment Canada weather stations. The graph in figure 5 charts brix against degree days. To update a sample taken September 14 to September 24:

- locate the starting brix (17.0)
- read off the corresponding degree days
- get the number of degree days between the 14th and the 24th from Environment Canada (90)
- add that to the starting growing degree days
- read off the corresponding brix (18.5)

Using this process, the computer could update an entire contour map to today's date, or, using forecasted weather, to a date a week in the future. In fact, the computer could replace the values of brix with the dates at which they will reach a given value. The result would be contours showing when the grapes could be expected to reach the desired maturity.

1991 TRIALS

The computer programs outlined in this paper will be tested during the 1991 growing season. The trials will take place in Kaleden, B.C. in a vineyard with a variety of topography, soil types and possibly clones. Three types of samples will be taken:

- quick samples, two berries each, reading brix only
- 40 berry samples, tested for brix, ph and ta
- conventional samples of predetermined areas

Resulting maps from both 2 and 40 berry samples will be compared to the conventional samples to determine the accuracy of the contours. Also tested will be the updating method.

CONCLUSION

It may be a little risky to present a paper with these kinds of ideas prior to the trials, but the purpose of the Wine and Grape forum is not only to provide facts about the growing of grapes and the making of wine, but to stimulate thought about how we can improve our techniques. I hope this paper contributes.

MY IMPRESSIONS OF WINE MARKETS IN JAPAN, SOUTH KOREA AND HONG KONG

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INTRODUCTION

Washington's wine and wine grape industries expanded rapidly during the late 1970's and the early 1980's. Washington is now the second largest producer of *Vitis vinifera* wines in the United States. Grape production stabilized at about 4,400 ha, while yields are dependent upon the season. Winery capacity expanded to accommodate about three million hectoliters of wine and continues to increase at a slow rate. Additionally, grapes and juice are sold to other states, including California, Michigan, Georgia, Arkansas, Idaho and Oregon, and other countries, including Canada and Japan, for processing. Bulk wines are also sold for blending and/or bottling in other states and countries. Bottled wines are competing in the international wine markets. However, most wineries in the state are not equipped to explore the potential for their products in

international markets and what the needs and demands are in the international arena.

The purpose of the trip was twofold: 1) collect information that would assist Washington wine, grape and juice producers in their efforts to improve their potential for international sales and 2) develop a first-hand knowledge of the Western European research efforts on wine and wine grapes, as well as to observe the wine producing regions.

In 1989 a project was proposed and funded to the IMPACT Center to examine the potential market for Washington wines in the Pacific Rim countries, primarily Japan, and the special requirements and/or problems associated with marketing wines in these countries. In addition to the IMPACT project, a proposal was submitted and partially funded by the International Program Development Office for the purpose of visiting with researchers and the wine industry in some of the wine regions in Western Europe. Matching funds for this portion of the trip were provided by the Irrigated Agriculture Research and Extension Center's development fund. Information regarding wine consumption and marketing were also collected during the European leg of the trip to complement the data collected in Japan, Korea and Hong Kong for IMPACT. Ms Suzanne Callendar, Graduate Assistant in the Department of Agricultural Economics (advisor Dr. Raymond Folwell), accompanied me throughout the trip. Mr. Jack Watson, Chair Benton County Cooperative Extension, accompanied us in Japan, South Korea and Hong Kong.

I would like to express my appreciation for the assistance we received prior to the trip from Mr. Brent Heinemann, Washington State Department of Agriculture, Agricultural Development Division, International and Domestic Market Development Section. The

selection of Japan, Korea and Hong Kong as stops were based on recommendations by Mr. Heinemann. During our stay in Japan we were greatly assisted by Mr. Kent Nelson of the Washington State Department of Agriculture and his very able assistant Ms Yuka Takahashi, Project Manager.

JAPAN

During our stay in Japan, appointments were arranged by the Washington State Department of Agriculture to visit with representatives of the various layers of wine and/or juice importers. In Japan we talked with individuals from about twenty different firms of various types and function.

The per capita consumption of wine in Japan is less than one liter per year. However, according to one source, 60% of the population does not drink wine. All individuals and firms with whom we talked expect this figure to double or triple in the next several years and eventually reach the U. S. per capita consumption of about 10 liters. According to one of the people we interviewed, imported wine sales in Japan for 1989 were 23 billion Yen (about $150 million). In April 1990 wine sales were 110 to 125% of the same period in 1989. The ratio of domestic versus import sales of bottled wines is 45:55, respectively.

The average Japanese wine consumer is not knowledgeable about wine. Most of the wines consumed are sweet white wines. More experienced wine consumers, as in other countries, tend to drink first dry white wines and later gravitate towards red wine. Most wine consumers are young women who particularly drink one glass of sweet white wine at a party. Wine is not consumed with food in the home. Generally, wine served in

restaurants to compliment food is in the more expensive restaurants. Sake and beer are the alcoholic beverages of choice to be consumed with food, mainly by men. Hard liquor is still the social drink of choice for men. Sparkling wine is gaining in popularity in Japan. However, its use is fairly restricted to special occasions. Nouveau style wines in the manner of the Beaujolais wines, and especially the true Beaujolais nouveau wines, are the latest fad in wines in Japan. Some Australian wineries are marketing an Aussie Nouveau with some success. Port is thought of as a cheap sweet wine. There have been some problems with sales of late harvest wines since the ethylene glycol incident with Austrian wines. Sherry's flavor is too strong for the Japanese consumer. When asked what characteristics were popular in wines consumed in Japan, the response was usually fresh and fruity. Many of those we interviewed thought that Chardonnay would be the wine varietal of the future in Japan. This would parallel the wine consumption patterns in the United States.

An effort is being made to educate the Japanese public regarding wine. Also, some effort is being made to get the Japanese consumer to associate food and wine combinations. We felt that any of Washington's dry white wines, except for heavily oaked Chardonnay, would go well with the delicate flavor of Japanese food. One of the more innovative firms with which we talked has a "mail-order" wine education program. The course lasts for a year. Study materials, including wine, are sent to the participants every month. The graduates receive a certificate and become "wine advisors". The company also organizes tours of French wine regions and operates wine salons.

Japanese wine consumers are label conscious from the standpoint of image.

French wines are the most widely sold wines in Japan. Bordeaux, Burgundy and Champagne regions of France have essentially "brand" recognition, regardless of the quality of wine in the bottle. In most instances "appearance" is everything. The limited number of wine consumers that really know wine do care about what is in the bottle. A major problem Washington State faces in wine marketing in Japan is a lack of image in Japan. California is American wine in Japan. Gallo is California wine in the eyes of most Japanese wine consumers.

Packaging is a very important aspect of selling wine in Japan. Wine when purchased is often used for a gift. Again, image is very important. A scuffed label is enough to make the wine unsalable, particularly for the gift market. For a premium image wine, the Japanese consumer is looking for an attractive label, high quality lead foil capsule and a deeply punted bottle. There seems to be a good market for 375 mL bottles, particularly in the restaurant trade.

A product for the gift market should also have a "story". As an example, a small icebox watermelon may sell for $10 (1500 Yen) in local fruit store. The same size and type of melon with the same external appearance and internal quality when sold as a gift, packaged, brand labelled and with a story, may sell for $100 (15000 Yen) in a major department store in the Ginza. Effort and perfection in handling can financially pay off in the gift market. One Japanese winery that we visited markets a three-pack with a white, a rose and a red wine labelled in harmonious colors. The label will vary with the occasion, ie. Valentine's Day, Wedding Anniversary, and so on; but the contents of the bottle do not change.

Display of wine in the major Ginza department stores is also based on image. Of the stores we entered, American, Japanese, Australian, and Spanish (among others) wines were grouped in what I would consider a bulk display. Cases were stacked on the store floor with several bottles displayed of a given wine. Some wines were shelf displayed. Wines from the French regions Bordeaux, Burgundy, and Champagne and the German regions Rheingau and Mosel were in a temperature- regulated (15° C), walk-in, carpeted, glass booth on the display floor. Having a wine placed in this area would immediately say to the Japanese consumer that this is a special wine with a good image. A goal for wine sales of premium quality wine in Japan should be to have the wine sold from this type of display.

On average most wine sold in Japan is in the 1000 to 1500 Yen ($8 to 10) range. Most wine consumed in restaurants is in the 5,000 to 10,000 Yen ($30 to 60) range. Imported wine prices range from 900 to 30,000 Yen ($6 to 200) or more. Prior to April 1990, alcohol taxes in Japan were based on the imported price of the beverage with rates of 40 to 50%. Now the alcohol tax is based on volume and it is the same for domestic and imported wines. There is no special tax on sparkling wines as there is in the United States.

Japanese wineries have been importing bulk wines as well as bottled wines. The bulk wines are blended with wines produced from Japanese grapes, predominately Koshu or Delaware (American type grapes). Japan produces about 300,000 MT of grapes per year. Most of the grapes produced in Japan are sold as table grapes. Of the remaining production, there are enough grapes left to produce 20,000 hL of wine per year.

However, 60,000 hL of wine are sold as domestically produced Japanese wine. After November 1, 1989, imports of unfermented juice (alcohol content less than 1%) were allowed. Sulfur dioxide can not exceed 350 mg/L and sorbic acid can not exceed 200 ppm (prefer none) in the finished wine. Japanese wineries are permitted to blend up to 75% nondomestic wine with 25% domestic wine to label it as Japanese wine. When special arrangements are made, up to 90% of the produce can be other than Japanese. Wines produced in Japan from juices from other countries are considered to be domestically produced wines. Currently, bulk juices and/or wines are imported into Japan from California, Washington, Spain, Chile, Argentina, France, Germany, Italy, and Australia. Chile and Argentina receive a favorable trade status in the form of reduced tariffs as they are considered less developed countries. One firm indicated that the bulk wines that they import from various countries are blended to develop a wine to match Japanese taste.

Almost everyone we talked to indicated that the State of Washington, not just Washington wines or agriculture, needs to develop an image. California has an edge due to the sun, sand, surf, and Disneyland image; and the large number of Japanese tourists that go to California. When asked what kind of image would sell, the terms "fresh" and "natural" were often used. Being an agricultural state is an advantage. Currently, Spain has an advantage in both bottled and bulk wines in that the citing of the next Olympic Games in Madrid has attracted the attention of the Japanese public.

While in Japan we were able to visit the wine and grape producing regions of Nagano and Yamanashi. We visited the Alps Company which produces both wine and

grape juice. The production facility is state-of-the art. One interesting point is that on the juice bottling line, every bottle is inspected twice - empty and filled. The young women that inspect the bottles are relieved every 15 minutes. There is a quality assurance program (TQC-Total Quality Control) set up for workers to come into the plant to study in their off-work hours how to improve the quality of the product. The laboratory is equipped to analyze ion content (K, Pb, Md, Ca), to measure radioactivity levels, and with spectrophotometers and a gas chromatograph. There is also a sensory evaluation room which is used to maintain product quality and uniformity. Most of the wines produced are made from American type grape cultivars - Koshu, Concord, Niagara and Delaware. Bulk wines are imported from Washington. We were also able to visit Mr. Yagasaki's trellis trial which he patterned after some research done in Washington by Dr. Walter Clore. In addition we visited one of Mr. Yagasaki's Concord grape growers. Concord grapes, and many other cultivars, are produced on overhead arbors in Japan. A point of interest, red wines are aged in sake bottles in the winery cellars. Prior to release of the wines for sale, wines stored in the sake bottle are recombined, refiltered and rebottled in a traditional wine bottle. Apparently, sediment, even in well aged red wines, is unacceptable.

The following day we visited Antori and Suntory wineries in the Yamanashi area. Both of these wineries produce varietal labelled wines from Vitis vinifera as well as the American grape type of wines. Antori has been importing wines from France for blending and bottling. The winery was equipped with a Vaselin press and a rototank for use with red wines. Pectic enzymes are used to clarify the juice after the grapes are pressed.

Suntory is one of if not the largest winery in Japan. One of the most notable

differences between Suntory and the other two wineries is the layout of the winery for tourist visits. Generally, wineries in Japan are not open for tours by large volumes of tourists. However, Suntory had guided tours for the busloads of tourists arriving at the winery. Suntory produces a full line of wines which include the Vitis vinifera wines as well as the standard Japanese style of wines. Suntory owns a winery in California and has formal arrangements in association with Schloss Vollrads in the Rheingau region of Germany, a major winery in the Bordeaux region of France and Robert Mondavi Winery and Firestone Vineyards in California.

SOUTH KOREA

Wine markets are entirely different in Korea and Japan. Our first meeting in Seoul was with Mr. George Pope, Minister Counselor for Agricultural Affairs, and his assistant Mr. Yong-Keun Ban, Agricultural Specialist, at the United States Embassy in Seoul. We had hoped to meet with Mr. Howard Wetzell, at the Agricultural Trade Office. However, the ATO was firebombed the week prior to our arrival. Mr. Pope was not very hopeful of the wine market in Korea, but thought that there was a potential for a grape juice market in Korea. Most of the wine market in Seoul is through the hotel and restaurant trade, therefore, the Embassy made appointments with the Wine and Food Managers at the major hotels in Seoul.

From our discussions with the Wine and Food Managers, we learned that all of the hotels order there wines from wine wholesalers who must put their orders through government officials. All hotels are polled to see if they are interested in importing a particular wine. A minimum of 100 cases of wine between all of the hotels must be

ordered before a wine will be imported. If the wine has never been imported to Korea, it must undergo testing by government officials - a prolonged and expensive process. As an example, one of the hotels decided to import Chateau Lafite-Rothschild wine. By the time all of the "testing" was completed, three bottles were removed from every one of the 100 cases of wine (25% of the wine was "tested"). Apparently, wine importation rules were simplified for the Olympic Games since the hotels expected to have increased wine sales due to the Western visitors. However, about half of the wine arrived after the Games were over. The net result of this is that the hotels are still holding large inventories of wine.

Most of Wine and Food Managers in Seoul are Western European trained (Swiss and German hotel schools). Therefore, most of the wine selected for the hotel wine lists are French, German, Swiss and Italian wines. If American wines are served, they are California wines. Some Korean wines are sold, but reportedly only one of them was considered to be of reasonable quality. The Korean wine industry is very small and is located in the southern tip of Korea. Bulk wines for blending might be useful; however, the political implications involved in their importation may be prohibitive.

The native drink is Soju. Soju is 25% alcohol and is produced by distilling fermented potatoes. It is colorless, has no flavor other than alcohol, and is very cheap (about $0.90 for 500 mL). As opposed to Japanese food the Korean food is highly seasoned, particularly with garlic and peppers. It would be very difficult to find a wine that would not be overwhelmed by Korean food.

Alcohol consumption is primarily by men, is not wine, and is usually "hard liquor" or soju.

The day of our departure from Seoul there was an article in the International Herald Tribune newspaper indicating that the Korean government was asking all importers of foreign luxury goods, and I quote "including wine", to cease their importation. I do not know what the final status of importation of foreign luxury goods is at this time. The call for cessation of importation may have been a negotiating strategy.

I would have difficulty in recommending that Washington wineries or even grape juice processors enter the South Korean market. To do so, you would need to have more than one of the major hotels agree to handling your product. The layers of government bureaucracy and corruption are formidable.

HONG KONG

We met with Mr. Phillip Holloway, United States Agricultural Trade Officer. Currently, the out migration from Hong Kong is 60,000 people per year. Most of the emigrants are from the high income brackets and highly educated. In Hong Kong business is controlled by the Hongs. One of the largest is Jardines which controls Dairy Farm, Wellcome Super Stores (150 outlets), and 7-11 (250 stores). Another large one is Hutchinsons which controls Wompona, Watson (water), and Park'n'Shop (130 stores). There are 12 importers of wine in Hong Kong.

Wine sales in Hong Kong are $2,000,000 annually with 120 wine labels imported into Hong Kong by 60 wineries. Wine is consumed primarily by young upwardly mobile Chinese men. Women under the age of 30 are starting to drink more beer and wine. Women over the age of 30 do not drink alcoholic beverages.

Of the American wines Cribarri is the most successful on the low price end of the

market. The product that is moving well is sold in the milk carton type of convenience package. The new dual income consumers are looking for convenience. Paul Masson is the second largest selling wine in Hong Kong. Both wineries are high on promotion, including in store promotions. Carafes sold with the wine have moved the Paul Masson wines. These wines are in the low end at 50 HKD ($7) for a carafe. Gallo is making slow progress but sales are increasing. European bottled wines are slipping in sales. Chateau Ste. Michelle (WA) wines are marketed in Hong Kong and have a good image. They are recognized as being separate from California wines and have a novelty value. Mr. Holloway thought that the back label comparing the latitude to the French wine regions was a plus. As in Seoul, the hotel and restaurant trade is dominated by European trained hotel and restaurant managers. Therefore, European wines dominate the hotel and restaurant trade. Wine is consigned to the older hotels, but the newer ones are not using consignment purchasing of wine.

An active International Wine and Food Society has an annual Pacific Rim wine and food competition with prizes for the Cabernet Sauvignon, Chardonnay and Sparkling wine categories. Wines entered for competition must go through the importers.

Hong Kong should be a promising market for Washington wine at least through 1997.

Farm Winery Presentation

The farm winery presentation was made by Mr. Barry Bieller, Manager of Industry Relations and Advertising with the Ministry of Labour and Consumer Services, Liquor Control and Licensing Branch

and

Mr. Adolf Kruger,of Wild Goose Farm Winery

Mr Bieller presented the current regulations to establish a Farm Winery. Mr Kruger presented his experience in following the steps and guidelines to obtaining a farm winery licence.

Province of
British Columbia

Ministry of
Labour and
Consumer Services

Liquor Control and Licensing Branch
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Victoria
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July 29, 1991

GUIDELINES FOR LICENSING FARM WINERIES IN BRITISH COLUMBIA

INTRODUCTION

Farm wineries are small scale wineries producing wine made from 100% B.C. grapes grown predominantly on the winery's own farm. Given the low level of production, farm wineries must be devoted to producing premium wines in accordance with the B.C. wine standards.

BASIC QUALIFICATIONS

As a condition of licensing, applicants must meet the following basic requirements:

Size:	Minimum	2 acres
	Maximum	None
Production:	Minimum	1,000 gallons
	Maximum	10,000 gallons
Source:	100% B.C. grapes of which a minimum of 75% must come from the winery's farm.	
Wine Making:	Within one year of licensing, all wine must be produced and bottled on-site.	
Standards & Labelling:	All wine produced must conform fully to federal labelling standards and the B.C. wine standards including sensory analysis before it may be sold.	

RETAILING

One on-site store will be permitted and must meet minimum architectural standards so as to preclude a simple roadside stand. The store must be a fully secured facility where the public can view and sample a display of the product and transact purchases in a reasonable retail surrounding. Proposed building plans must be submitted for approval in principle.

Sales may be made to the public or licensees - including Licensee Retail Stores (Beer and Wine Stores) and Special Occasion Licensees - at no markup, although Liquor Distribution Branch floor pricing rules do apply. All applicable federal taxes and excise duties, in addition to provincial social services tax, must be collected.

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Due to the low levels of production, it is not expected that LDB stores will stock farm wines but applications may be made to the LDB. It should be noted that automatic listings will not be given. If an application for listing with the LDB is successful it will be sold at the applicable estate wine markup level.

Regardless whether product is sold through the LDB or elsewhere all wines require an application for a listing with the LDB and a CSPC number. Product may not be sold until this number is issued by the LDB.

APPLICATION PROCESS

Interested parties should approach the Liquor Control and Licensing Branch for approval in principle for a farm winery licence. The application should include the following:

(i) A general prospectus or feasibility study conducted by an outside agency such as a firm of chartered accountants. The study should contain pro forma financial information covering a three year period and include a statement of assets and liabilities, a statement of operations, and a schedule of production and equipment costs, incorporating all applicable provincial and federal taxes.

(ii) Evidence of sufficient grape supply to meet both the requirements of existing contracts with commercial or estate wineries as well as the proposed winery venture.

(iii) Number of acres dedicated to grape production including amount per varietal.

(iv) A list of proposed wines, including quantity to be manufactured per annum for each wine.

(v) Proposed floor plans for the winery, including plans for the on-site store, should one be proposed.

(vi) Written material regarding the expertise of the persons making the product and plans as to how quality will be maintained.

(vii) A completed application form including criminal record search.

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If in the first year the grapes are to be crushed and fermented other than on the winery site, and/or the wine is to be stored and bottled elsewhere, details of the proposed arrangements should be fully explained in the letter of application.

Once approval in principle is granted, site construction and other required work may begin. Financial arrangements regarding taxation should also be finalized with both the Federal and Provincial Governments.

When the winery site is finished construction and the winery is ready to initiate sales, the site will be inspected by the LCLB and the winery licence issued.

MISCELLANEOUS CONDITIONS

1. If or when production reaches 10,000 gallons, and the licensee wishes to increase production further, the farm winery will be required to apply for and meet the requirements of an estate winery licence.

2. Consolidation of farm winery licences such as in a cooperative venture is not permitted.

3. Licence fee is $500.00.

4. Licensees are required to have product liability insurance totalling $5 million.

5. Government does not guarantee the financial viability of farm wineries as they are unlikely to yield income sufficient to provide an adequate single source income.

6. Applicants may not be associated financially or otherwise with a licensed establishment e.g. neighbourhood pub, hotel, etc.

7. Applicants must consent to a criminal record search.

CONTACT PERSONS

1. Listings, Financial Reporting and On-Site Store

   - Mr. Peter Choate, Director of Purchasing, Liquor Distribution Branch, 3200 East Broadway, Vancouver, B.C., V5M 1Z8 (660-3675).

   - Mr. Mark Fukuhara, Manager Retail Accounting, Liquor Distribution Branch, 3200 East Broadway, Vancouver, B.C., V5M 1Z8 (660-5184).

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- Mrs. Terry Bergen, Manager of Agency Store Programs, Liquor Distribution Branch, 3200 East Broadway, Vancouver, B.C., V5M 1Z8 (660-5130).

2. Licensing

- Mr. Allen Michalchuk, Sr. Licensing Officer, Liquor Control and Licensing Branch, Parliament Buildings, Victoria, B.C., V8V 1X4 (387-1254).

3. Federal Taxation

- Mr. Lou Campanaro, Manager, Excise Duty, #201 - 4664 Lougheed Hwy., Burnaby, B.C., V5C 6C2 (666-7673).

4. B.C. Wine Institute

- Mr. Nick Clark, Chief Executive Officer, Ste. 5 - 1864 Spall Road, Kelowna, B.C., V1Y 4R1 (762-4887)

FARM WINERIES

The First Year.

As most of you know 1990 was the year of the farm wineries. With a lot of fanfare and publicity Lang Vineyards was the first farm winery to open followed shortly by Wild Goose Vineyards and Hillside Cellars. Because of the lobbying efforts of individuals, the efforts of the Grape Marketing Board, as well as the wisdom of the premier at the time, farm wineries came into existence.

Today, a year later, many of you must be curious as to how the farm wineries have fared. Did they succeed? How are they doing now? How did they do it? Are there any problems?

"Did they succeed?" Yes, in many ways they did succeed. They proved that good wine can be made by a small winery and all three sold out their 1989 vintages. On the other hand, one year is too short a period to really determine success. The jury will be out over the next two to three years before that question can really be answered.

"How are they doing today?" Like I said, it takes time to judge. However, the 1990 vintage was good and all three wineries are busy selling wine. I may add that A & H Vineyards of Summerland and Domain de Chaberton of Langley have also joined the ranks of farm wineries.

"How did they do it?" I'll answer this question as detailed as possible to give you an insight into the creation of a farm winery.

"Are there any Problems?" In any business there are problems. Some are general, some are specific. Taxation affects the whole industry. After you see most of your hard earned money disappear in the form of taxes you wonder why you entered the wine business in the first place. One problem that applies specifically to estate and farm wineries is classification. All over the world wine is considered an agricultural product. Germany awards medals to the best wines in recognition of the viticultural efforts of their vintners. Winemaking starts in the vineyard. We spend endless hours trying to grow premium grapes for premium wines, only to be classified as light industry. In other words in the eyes of the government we are manufacturing wine not making or creating it. Certainly it is a lack of understanding the whole winemaking process. Without quality grapes there can be no quality wine, I only hope that our Minister of Agriculture understands this intricate connection and starts to rectify this ridiculous classification. Another specific problem is highway signage. We all know that most wineries, and in particular farm wineries. are located off the beaten track. Before we even opened our winery we approached the Dept. of Highways for a directional sign. Almost two years later we are still at it. We were never told that we would not receive a sign. What we got was excuses, like " the sign shop is busy making signs for the Coquihalla connector," or "we have not been informed that you are in fact a tourist attraction" or "the decision for a sign is made in Victoria". Well, try to find out who makes the decision. Talk about beating your head against the wall. Proper highway signage is essential to our business, excuses will not get tourists travelling our way.

"What is required to start a winery? First you require a minimum of two acres of producing vineyard. Second, a place to build a winery. And now the most important, You need money !! How much you will need shall be covered in a few moments.

Since Mr. Bieller of the LCB gave you a short history of the events leading to the creation of farm wineries and a guided tour through the licensing process, lets begin where he left off. Please remember that the "Guidelines For Licensing Farm Wineries" are they key to a whole set of other licenses and approvals required prior to opening.

The first step is to check the zoning by-laws in your particular district. Basically, are you allowed to build a winery in your area? If not, can the area be rezoned? If you are strictly in an agricultural zone, you must inform the Regional District of your intentions. If you are required to apply for a land use change, this must be done through the Agricultural Land Reserve Commission, and be prepared for a long wait for an answer, as the commission only meets twice a year to deal with applications.(If you do not purchases any grapes from outside your farm, you may not require an approval.)

Next comes the building permit. If you are in an agricultural area and you want to convert an exsisting building, no problem. But if you want to build a new building or you live within city limits, a permit is required. Regardless whether you had a permit or not, your winery requires at least three inspections. One health inspection, one fire inspection and one by the local liqour inspector.

The health inspector requires that you have a public toilet, a double sink, and whatever other regulations exist in the area that you live in.

Even the smallest and most simple winery layout requires some thought. Basically three sections are needed. A fermentation-tank area, a space for bottling, and a storage area. Make sure you have drainage and a sump to get rid of wastewater. For the tasting room use your imagination and follow the guidelines of the health inspector and the LDB. So far you have spent a good part of your money and you are not even close to having a winery.

The next thing is to purchase process equipment. You need every-, thing from a crusher to a sterile membrane filter. Equipment is expensive and difficult to find, especially for a farm winery because most equipment is underutilized. Take for instance a sterile filter cartridge which will cost you about $550. You will push say, 2000-5000 gallons through, while a larger winery will filter 30000-50000 gallons with it. This applies to all machinery and supplies purchased. The cost of equipment per gallon of production plays a significant part in the financial planning of your winery. It certainly looks impressive to have everthing in gleaming stainless steel, however, regardless of how much money you have to spend, at the low level of farm winery production it makes economic sense to look at the options. Cost is further influenced by the ingenuity of the individual. One person will scrounge, improvise, and make do, while the next person won't touch anything that isn't brand new and ready made. Regardless of your inclinations you will need the following minimum equipment.

Crusher-Destemmer
Press
Transfer Pump
Tanks
Plate Filter
Sterile Filter (Optional but recommended)
Bottle Filler
Corker

The next step now is winemaking. I will not discuss the aspect of this operation because it is a subject in itself. However, I would like to draw your attention to two stages of the operation. The first one is material handling. A 1000 gallon production requires about 7 tons of grapes, that amounts to 35 bins of fruit. These grapes have to be crushed and pressed, the juice to be extracted and the pomace discarded. Certainly not a job you do alone on a Sunday afternoon. So put your brain in gear and sort it out before you start, otherwise you will have problems. Secondly is the commitment to produce premium wines. (It is a requirement for obtaining a license.) Make sure that your winemaking efforts conform to the B.C. wine standards. These are minimum requirements and if your wines fall below the given values they will not be passed by the B.C.W.I. tasting panel. Read and understand the wine standards before you start your wine making proccess.

By now you have completed two phases in your venture. Your tanks are full, the fermentation is going, your are on your way!! But let me tell you that you are not even close to entering the wine business.

Lets look back for a moment. Before you started out you made your feasability study, gathered supporting documents, and applied for a winery license. You received your approval in principle from the LCB. With the approval the Liquor Distribution Branch has been notified as to your winery intentions. In due time you will be contacted by the LDB and you'll receive information and directions in establishing an agency store. This is totally separate from the winery license and it costs you nothing. However, from here on in your selling procedures are dictated by the LDB. There are no ifs, ands, or buts. The rules and regulations of distribution are too numerous to go into. You'll get all the help you need from the LDB to become established.

Nevertheless you have to deal with the "Listing Application" and "Label Approval." For every wine that you want to sell, you must obtain a Canadian Standards Product Code, CSPC in short. This is obtained with an application form through the LDB. You must remember to get the CSPC number before you print your labels because the number must appear on your label. Your label designs have to be submitted to the Canadian Consumer & Corporate Affairs Department for approval. Not to judge your artistic talents, but there are rules governing size of lettering, quantity declaration, english-french lettering, etc. etc. Also make sure your labels conform to the B.C. Wine Standards. i.e. Appelation B.C.

While all this is going on you are struggling to make wine. Racking, fining, filtering, you need bottles, corks, capsules, storage for bottles and cool storage for full ones.

Finally your wines are finished. Everything is in place, all you need is approval by the B.C.W.I. tasting panel. Five bottles and an application have to be submitted for tasting. If your wines are approved the LCB will be informed and within a few days you finally have your license. If the wines are rejected you will be told what is wrong. If the fault can be corrected you can re-submit the wine. If the fault is permanent, you are simply out of luck.

A few tips on tasting approval. Don't bottle all your wine and then submit it for approval. If the wine is faulty you have wasted a lot of money in bottles and corks. Submit a tank sample instead, although you'll be requested to resubmit a sample of the finished wine later on. Before you submit wines, have them analysed by a qualified lab. Most large wineries will do this for a reasonable fee. Don't be afraid to get a second opinion. Even established wineries have their wines analysed.

At last the winery has been established, and now the wines are ready for sale. Before we get into business lets see how much money we had to spend.

Basic Cost To Establish A Farm Winery
(Minimum Cost Based On 1000 Gal. or 4500 L)

Facilities		Min. Cost	Max. Cost
Winery	>	3000.00	?
Tasting Room	>	to	?
Storage Area	>	10000.00	?
Basic Equipment			
Crusher- Destemmer		500.00	4500.00
Press		2000.00	8000.00
Transfer Pump		500.00	900.00
Tanks 3 @ 500 Gal.		3000.00(Poly)	6000.00(SS)
Plate Filter		300.00 ?	2500.00
Sterile Membrane Filter(30" Cart)		1250.00	3700.00
Filler		1400.00	1400.00
Corker		100.00	?
Labeller		?	1500.00
Hoses,Valves,Fittings		500.00	1000.00
Air Conditioner		600.00	600.00
Basic Lab Equip.		500.00	500.00
	Total	13650.00	30600.00

Wine Shop	
Cash Register	900.00
Misc. Glasses etc.	250.00
Total	1150.00

Production Cost

Per/ton yielding 630 litres or 840 bottles

Grapes	900.00/ton
Corks,Labels,bottles, Capsules	530.00
Total	1430.00

Labour

Based on $10/hour

Crushing- Pressing	60.00
Racking	20.00
Filtering	30.00
Bottling,Dressing, Misc.	250.00
Total	360.00

Sub-Total 1790.00 or 2.13/bottle

Sales Cost and Taxes
(Based on $7.50/bottle)

PST	.64
GST	.45
Excise Tax	.38
	1.46/bottle

Misc. Costs

Administration	.47
Winemaking	.05
	.49/bottle

Total Cost per bottle $4.11

Operating Costs For One Year

Administration, Insurance, Utilities, Advertising, Travel, Freight, etc.		5000.00
	to	9000.00

These costs will very according to the size of your winery.

Repairs And Maintenance		2000.00
Total	say	10000.00

Please note that all costs and fees are approximate.

The Business Of Selling Wine

After this great snakes and ladder game, we have finally arrived at the spot where we wanted to be in in the first place, namely in a position to sell wine. All romantic notions aside, you are in business to make money. It is that plain and simple. If you think the road up to here was pretty rough, you are now facing the biggest obstacle of them all. You must now convince the world to buy "Your" wine. There are no rules to ensure success and competition is fierce. B.C. wines are approaching excellence. You now have to coax the consumer that your wines are just as good or even better (VQA approval at least gives you a bit of leverage) then your competitors.

Personally I do not think selling 1000 gallons of wine, or 6000 bottles, is all that difficult. However, for every 1000 bottles more you have to work that much harder. For selling, the following options are open to you.

1.) Wine Shop Sales (easiest and most profitable.)

2.) Restaurant Sales (profitable, but difficult to sell to)

3.) Beer & Wine Stores (fair business, but they receive a 10 % discount)

4.) B.C. Wine Institute (will not sell wine for you, but will inform you of sales opportunities and possible contacts.)

5.) Tastings, Wine Festivals, Competitiones. (it will cost you time and money to participate in these activities. But it is a good way to make contacts with buyers, and it gives you exposure to the public.)

There you have it. If you decide to go on this exciting but sometimes frustrating journey, I wish you the best and good luck along the way. Thank-you.

10 Steps To A Farm Winery

1. Make application to the Liquor Control and Licensing Branch for approval in principal.

2. Obtain approval in principal by following guidelines for licensing farm wineries.

3. Check with authorities in your area regarding zoning by-laws, building permits, health and fire inspections.

4. Make arrangements with the Liquor Distribution Branch to set up an agency store.

5. Have your facilities inspected and arrange to carry $5 million liability insurance once you open your business.

6. Apply for Social Service Tax Number. Register for GST and Excise tax.

7. Obtain the B.C. Wine Standards and make sure that your wines are made accordingly. Your label designation must also agree with the British Columbia Appelation.

8. Make listing applications for your wines and submit your labels for approval to the Consumer and Corporate Affairs Dept.*

9. Submit wines to the B.C.W.I. for tasting and approval.

10. Pay $500 fee to receive winery license.

NOTE:
Allow at least one year to accomplish the above.

* Contact mr. Jack Gerow, Consumer and Corporate Affairs Dept., Kelowna. Telephone (604) 861-6045.

CHAMPAGNE PRODUCTION

This presentation was shared by 3 people. Mr. Ken Visser, Executive Director, Marketing and Special Projects at Inkameep Vineyards dealt with the project between Inkameep Vineyards and Schramsberg Associates International; Mr Daniel Lagnez, Enologist, Vice President and General manager of Production at Mission Hill Vineyards; Mr. Eric von Krosigk, Enologist at Summerhill Vineyards. Mr. Von Krosigk has not prepared a paper of his presentation, which transmitted his firm belief that the Okanagan area is capable of producing world class champagne.

JULY 26, 1991---THE SCHRAMSBERG PROJECT----KENN VISSER

I do not believe I need to point out to anyone in this room today, how the Canada/U.S.A. Free Trade Agreement and the G.A.T.T. ruling altered the landscape of the British Columbia grape/wine industry. I also do not have to elaborate on the need for all of us as individual growers/wineries and collectively as an industry to seek alternative market driven solutions to what faces us in 1995.

As the largest vineyard in the province, farming 15% of the remaining grape acres in B.C., Inkameep realized in 1988 that the number of wineries making premium wine from 100% B.C. grapes could not fully utilize its post F.T.A. production as well as any new acres Inkameep would need to plant in order to remain a viable farming operation.

Looking south, we also realized that there was a stark contrast between the "generic" and "premium" wine industries in the U.S.A. Large highly mechanized vineyards producing grapes for the jug wine industry of California were struggling to cover costs and avoid foreclosures. At the opposite end of the spectrum, growers producing for successful premium wineries were receiving the highest returns ever for their grapes.

In an effort to understand the dynamics of this premium grape/wine industry from both the production and marketing side, I spent three weeks in California during May and June of 1988. It was on this trip, thanks to an introduction provided by Mr. Dick Cleave, that I visited Schramsberg Vineyards & Cellars in the Napa Valley and met Mr. Jack Davies.

Twenty-five years ago, when Mr. Davies purchased the defunct and overgrown Jacob Schram Estate, there were only two companies in the U.S.A. producing method champenoise sparkling wine. Today there are over forty-five brands of California champagne, but Schramsberg is still considered one of the most prestigious producers. In 1972, U.S. President Richard Nixon took Schramsberg "Blanc de Blanc" to China, and every U.S. president since then has served Schramsberg wines at the White House.

Schramsberg Associates International is the international operating company of the Schramsberg Vineyards Company. It was organized in January 1989 as a vehicle for investigating and investing in special production opportunities available in the international wine industry. Its initial venture was the establishment of the first California owned winery in Europe. The project is being set up in Portugal to produce method champeniose wines for sale within the EEC and U.S.A.

After listening to my post F.T.A. tale of horror, that was spiced with some possibility, Mr. Davies agreed to visit our region and explore its options. In early October 1988. Mr. Davies and the Schramsberg winemaker, Mr. Alan Tenscher, spent four days tramping through vineyards sampling grapes and visiting B.C. wineries to taste the resulting wines.

At the time I was surprised by how much of the tour was focused on vineyards and the tastes of our regions' grapes. Although there were very few acres of traditional champagne grape varieties growing in the valley, there were enough for them to taste distinct differences between certain clones and vineyard sites.

By the end of their visit, both Mr. Davies and Mr. Tenscher agreed that our climate and soils indicated a promising potential for the production of world class premium champagne. However, the limited amount of champagne grape varieties planted and available combined with the variations of microclimate and viticultural approach presented to them a need for more in depth understanding of the possibilities that could only be defined by a pilot project. It was becoming clearer to me that the overall concern regarding the viability of the champagne venture was centered on viticulture rather than winemaking.

In 1990, Schramsberg Associates International, Inkameep Vineyards and Southview Farms collaborated on a research and development project that was designed to answer some of the areas of uncertainty surrounding an Okanagan champagne venture. The 1990 R & D Project utilized grapes from thirteen vineyards including the Summerland Research Station. These vineyards represented the North/South spectrum of the valley with varying soil types and provided clonal comparisons within and between vineyard sites.

Working closely with the growers providing grapes to the project, we identified specific areas of all vineyards from which the grape lots would be picked and monitored these sites over the growing season. All grapes were harvested at predetermined parameters and each two hundred fifty pound lot was vinted separately.
Larger amounts of certain varieties from single locations allowed us to evaluate the effects of different winemaking techniques and treatments.

As you are all well aware, I am not a winemaker and it is not my intent to try and provide you with any great technical detail. What I would like to share with you, is how this project has significantly altered my perception of premium wine production.

When we began this R & D project, it was our hope that if we could put British Columbia grape varieties in the hands of proven champagne expertise, the results would be spectacular. I expected to see clonal and site variations within the wine lots, but that the differences exhibited would be primarily flavor nuances that would form the basis for blended complexity. It was the intent of the project to let the grapes speak through the wines.

The results were spectacular in that every wine lot did sing a different note, but almost every wine also sang a similar tune that had a strong echo of viticultural practices.

An overriding characteristic in many of the wine lots was either a distinct vegetal note or a strong phenolic flavor. In comparing the individual lots to the projects' viticultural records and canopy assessments there appeared to be a direct correlation between the amount of vigor expressed in the vineyard and the degree of fruit exposure, to the vegetative or phenolic character exhibited by the wines.

This correlation is not a revelation, since every wine region of the world fully recognizes the relationship between canopy management and wine quality. The revelation for me was the degree to which the canopy flavor characteristics were so intensely imprinted upon the wines and in many cases shadowed the more positive varietal nuances.

WAS THE PROJECT A FAILURE? ABSOLUTELY NOT!

One of the major concerns in assembling the champagne cuvee is recognizing how subtle aromas are magnified by the presence of the effervescence in the finale wine. Our efforts in picking these base wines apart were directed towards understanding how we can best manipulate the grapes within our climate and microclimates to accentuate the positive characteristics and reduce negative vineyard related flavors and aromas that can overwhelm the intentionally layered complexities in the champagne.

Our region, with its variation of soils and sites and lack of rainfall allow us a great latitude of control and manipulation within our vineyards. This is our advantage over other growing areas in which vineyard canopies are more heavily influenced by different weather patterns and rainfall.

The awareness that our vineyard practises play such a significant role in fine tuning wine quality helps me to feel very optimistic about the future of Inkameep's champagne project and about the potential for ~~the~~ AJ evolving improvement in the quality of British Columbia wines.

Inkameep Vineyards and Schramsberg Associates International are continuing our champagne project. Much of our concentration this year has been in our own vineyard. With the help of Mr. Tucker Catlin, Schramsberg Associates Internationals' executive vice-president and viticultural coordinator, we are learning to adjust the taps of control and to improve our grape quality. These efforts will hopefully be quantified by the wine lots we make this fall. While we do not anticipate we can conquer every aspect of control in one year, we have already witnessed changes in our vineyard that we know are the direct results of our efforts and approach.

Our goal at Inkameep is to make a method champenoise sparkling wine of world class quality that can be sold and served at home and internationally with great pride. It is our hope that the Inkameep sparkling wines will be but one of many premium British Columbia champagnes that will be recognized world wide for their outstanding quality and uniqueness. As we look towards the year 2000, let us envision that thousands of Canadians will toast the Millennium with the champagnes of British Columbia. If we can succeed in this goal by continuing to improve the quality of all [redacted] British Columbia wines through our efforts in the vineyards, then we will also be able to celebrate the century looking out on our fully planted vineyards that form a strategic partnership with a successful and growing British Columbia wine industry that is flourishing because of quality.

PRODUCTION OF SPARKLING WINE

* METHODE CHAMPENOISE *

MISSION HILL VINEYARDS

DANIEL A. LAGNAZ, ENOLOGIST
VICE PRESIDENT &
GENERAL MANAGER OF PRODUCTION

JULY 26, 1991

GRAPE FORUM - SUMMERLAND

JULY 25/26, 1991

LADIES AND GENTLEMEN - GOOD AFTERNOON

FIRST OF ALL I WOULD LIKE TO THANK YOU FOR INVITING ME TO SPEAK TODAY ON BEHALF OF MISSION HILL VINEYARDS, ON THE OCCASION OF YOUR SECOND GRAPE FORUM.

THE SUBJECT OF THIS PRESENTATION IS THE PRODUCTION OF CHAMPAGNE.

WHAT AFTER ALL, IS CHAMPAGNE?

I AM SURE IF YOU ASK SOME OF THE OLD TIMERS IN CANADA, THEY MAY SUGGEST NAMES SUCH AS FUDDLE DUCK, QUEENIE, YELLOW BIRD, BABY DUCK, TO NAME A FEW. TO OTHERS, CHAMPAGNE MEANS ANYTHING THAT IS BUBBLY, FROM EL CHEAPO PORPHERY PEARL TO SPUMANTE, TO AN ARTIFICIALLY CARBONATED WHITE OR RED WINE BLEND, WINES PREPARED USING THE CHARMAT OR CUVE CLOSE PROCESS, THE TRANSFER METHOD, AND WHAT I WOULD SUGGEST IS THE ONLY WAY OF MAKING PROPER SPARKLING WINE, THE METHODE CHAMPENOISE.

IN THE NEXT 20 MINUTES OR SO, I WOULD LIKE TO BRIEFLY DISCUSS THE CHARMAT PROCESS, THE TRANSFER METHOD, AND AT MORE LENGTH THE METHODE CHAMPENOISE, WHICH IS AT PRESENT, THE ONLY CHOICE OF MISSION HILL VINEYARDS FOR OUR SPARKLING WINES.

FIRSTLY, I WOULD LIKE TO TOUCH ON THE HISTORICAL ASPECTS OF CHAMPAGNE MAKING AND ITS ORIGINS:

IT IS BELIEVED THAT VINES HAVE EXISTED IN THE CHAMPAGNE AREA SINCE THE TERTIARY ERA WHICH BEGAN 60,000,000 YEARS AGO AND ENDED A MILLION YEARS AGO. IT IS DURING THIS PERIOD THAT THE HIGHEST MOUNTAINS WERE FORMED.

AT THE TIME OF THE ROMAN CONQUEST IT IS PROBABLE THAT JULIUS CAESAR'S ARMY DISCOVERED THE REGION AND THAT THE VINEYARDS AND THE COMMERCE OF WINE BEGAN TO DEVELOP, ALTHOUGH THE PRODUCT OF THE VINEYARDS HARDLY RESEMBLED THAT WHICH WE ADMIRE TODAY.

NEAR THE END OF THE 17TH CENTURY, SOME MEN OF THE LAND, ESPECIALLY DOM PERIGNON, THE CELLARMASTER AND STEWARD OF THE ABBEY OF HAUTEVILLERS, SUCCEEDED WHERE OTHERS FAILED. BY COMBINING THE QUALITIES OF THE TASTER, WITH THE PATIENCE OF THE OBSERVER, HE MASTERED THIS FERMENTATION AND OBTAINED A CLEAR WINE WITH CONSTANT EFFERVESCENCE.

CHAMPAGNE, SUCH AS WE APPRECIATE TODAY, WAS BORN.

FROM THE YEAR 1820, SHIPMENTS OF CHAMPAGNE ACHIEVED A WIDER SCOPE AND BOTTLES OF WINE BEGAN TO LEAVE THE CELLARS OF REIMS, EPERNAY AND AY BY THE MILLIONS.

TODAY, THE PRODUCTION OF FRENCH CHAMPAGNE IS STRICTLY LIMITED AS A RESULT OF THE LAW OR DECREE OF JULY 1927. THE CHAMPAGNE AREA OF TODAY REPRESENTS ONLY 2% OF ALL GROWING AREAS IN FRANCE. THE LARGEST RECOGNIZED BEING:

THE MOUNTAINS OF REIMS
THE VALLEY OF THE MARNE
THE COTE DES BLANCS
THE SOUTH OF THE MARNE DEPARTMET
THE REGION OF VITRY-LE-FRANCOIS
THE DEPARTMET OF THE AUBE

IN THE PRODUCTION OF CHAMPAGNE, THE GRAPES USED MUST COME FROM A PRECISELY DEFINED CHAMPAGNE ZONE.

ONLY THREE VARIETIES OF GRAPES, WHICH ARE PERFECTLY ADAPTED TO THE SUB-SOIL AND HARSH CLIMATE OF THE CHAMPAGNE REGION, ARE AUTHORIZED IN THE MAKING OF CHAMPAGNE: -

- PINOT NOIR - WHICH BRINGS STRENGTH AND CHARACTER
- PINOT MEUNIER - WHICH BRINGS FRESHNESS AND YOUTH
  CALLED MEUNIER (MILLER) BECAUSE OF THE FINE WHITE DOWN COVERING ITS LEAVES WHEN STARTING TO GROW.
- CHARDONNAY - WHICH BRINGS FINESSE AND ELEGANCE

IN THE CHAMPAGNE AREA, 35% OF THE PLANTED SURFACE IS MADE UP OF PINOT NOIR, 39% OF PINOT MEUNIER AND THE REMAINING 26% OF CHARDONNAY.

I WOULD NOW LIKE TO DESCRIBE TO YOU 3 SECONDARY FERMENTATION PROCESSES USED IN MAKING SPARKLING WINES, INCLUDING:

1) THE CHARMAT PROCESS
2) THE TRANSFER METHODE AND
3) THE METHODE CHAMPENOISE

<u>CHARMAT PROCESS</u>

IN THE MAKING OF SPARKLING WINES USING THE CHARMAT OR CUVE CLOSE PROCESS, A "CUVEE" IS PREPARED CONTAINING WINE, SOME RESIDUAL SUGAR AND YEAST NUTRIENT. THIS BLEND WOULD THEN BE FILTERED THROUGH STERILE GRADE PADS AND ALSO SOMETIMES OVER A 0.45 MICRON MEMBRANE FILTER, TO AVOID ANY POTENTIAL MICROBIAL INFECTION.

ONCE THE WINE IS IN THE TANK AND TESTED FOR MICROBIOLOGICAL STERILITY, YOU WOULD ADD A YEAST MEDIA, WHICH IS A BATCH OF WINE CONTAINING A VERY HIGH YEAST POPULATION, OFTEN TO THE RATE OF 1 X 10 YEAST CELLS PER MILLILITRE, OR 10,000,000 YEAST CELLS PER MILLILITRE. ALL VALVES OF THE PRESSURE TANK ARE CLOSED OFF TIGHTLY AND THE FERMENTATION PROCESS ALLOWED TO PROCEED. AS IN ALL FERMENTATION, THE TEMPERATURE IS OF UTMOST IMPORTANCE.

AT LINEDMANS WINES IN AUSTRALIA, FOR WHICH I WORKED FOR NEARLY 3 YEARS, WE FERMENTED OUR SPARKLING WINES AT BETWEEN 20 - 25 DEGREES CELSIUS. THE AUTOMATED COOLING SYSTEM WOULD CUT IN AND OUT TO MAINTAIN THE FERMENTING WINE WITHIN THESE TEMPERATURES.

AT COMPLETION OF THE FERMENTATION, THE COOLING WOULD AGAIN CUT IN AND COOL THE NOW SPARKLING WINE TO AROUND 3 TO 5 DEGREES. THE REDUCTION IN TEMPERATURES ALLOWS FOR BETTER CO_2 SOLUBILITY AND ALSO BETTER HANDLING OF THE PRODUCT ITSELF. IT IS NOT USUAL TO KEEP CHARMAT PROCESSED SPARKLING WINES IN CONTACT WITH THE LEES FOR EXTENDED PERIODS OF TIME. THIS IS THE REASON WHY CHARMAT PROCESSED SPARKLING WINES USUALLY TASTE FRESH & FRUITY WITH NO YEAST CHARACTER AT ALL.

THE NOW FRESHLY FERMENTED, CHILLED WINE IS COARSE FILTERED OVER A DE FILTER, SUGAR AND ACID ARE ADJUSTED, AND IT IS IMMEDIATELY BOTTLED THROUGH A STERILE PAD AND MEMBRANE FILTER. ALL OPERATIONS ARE UNDERTAKEN IN A PRESSURIZED, CLOSED SYSTEM. THIS IS A VERY ECONOMICAL METHOD. FOR EXAMPLE, AT LINDEMANS WINES WE HAD PRESSURE TANKS OF MORE THAN 100,000 LITRE CAPACITY OR SLIGHTLY MORE THAN 11,000 CASES OF FINISHED SPARKLING WINE READY IN LESS THAN A MONTH.

TRANSFER METHOD

FOR THE TRANSFER METHOD, YOU WOULD PREPARE A CUVEE OF STERILE FILTERED WINE, ADD ENOUGH SUGAR FOR YOUR REQUIRED CO 2 PRESSURE, YOUR YEAST CULTURE AND MIXING CONSTANTLY, BOTTLE IT IMMEDIATELY. IT IS USUAL TO CAP THE BOTTLE WITH A PLASTIC STOPPER CALLED A 'BIDULE' AND A METALLIC CROWN AS CHAMPAGNE CORKS ARE QUITE EXPENSIVE ($0.25 EACH APPROXIMATELY).

THE SECOND FERMENTATION WILL TAKE PLACE IN THE BOTTLE ITSELF, TAKING UP TO 30 DAYS TO REACH TOTAL DRYNESS. WHEN IT IS TIME TO BRING THIS SPARKLING WINE ON TO THE MARKET, RATHER THAN HANDLING EACH BOTTLE INDIVIDUALLY AND RIDDLING THE YEAST DOWN TO THE NECK, THE BOTTLES ARE PLACED ON A BOTTLE CONVEYOR, THE CROWN AND BIDULE ARE PUNCTURED BY A STRONG NEEDLE THROUGH

WHICH THE WINE FLOWS TO A PRESSURE TANK UNTIL EVERY BOTTLE IS EMPTIED. THE BOTTLES ARE THEN WASHED AND STERILIZED.

THE WINE IS ADJUSTED FOR SWEETNESS IN THE HOLDING TANK, FILTERED AND THE NOW CLEAN BOTTLES ARE AGAIN FILLED, CORKED WITH A PROPER CHAMPAGNE STOPPER AND A WIRE HOOD OR 'MUSELET'.

METHODE CHAMPENOISE

AS YOU MAY KNOW MISSION HILL VINEYARDS IS A SMALL PRIVATELY OWNED WINERY. DURING OUR TEN YEARS OF EXISTENCE WE HAVE ACQUIRED THE REPUTATION OF BEING INNOVATIVE. WE INTRODUCED THE MARKET TO HIGH CALIBRE WINES AND HAVE DEVELOPED A LARGE RANGE OF VARIETAL WINES SOLD UNDER OUR PRIVATE RESERVE SERIES LABEL. THE GROWERS UNDER CONTRACT TO MISSION HILL VINEYARDS ARE TO BE CONGRATULATED. SINCE 1983, MISSION HILL VINEYARDS HAS INSISTED THAT GROWERS DELIVER THE GRAPES WITHIN 24 HOURS OR LESS OF PICKING, AS A WINEMAKER CAN ONLY BE AS GOOD AS THE QUALITY OF THE GRAPES BEING DELIVERED.

THE RESULTS OF THIS STRINGENT AGREEMENT IS EVIDENT IN THE OVER 260 AWARDS THAT OUR WINERY HAS WON IN THE PAST 8 YEARS.

AS YOU MAY NOTICE, I HAVE AVOIDED CALLING MISSION HILL'S SPARKLING WINE 'CHAMPAGNE'. IT IS NOT BECAUSE I HAVE A PARTICULAR INTEREST IN PROTECTING THE FRENCH NAME 'CHAMPAGNE' - ALTHOUGH I MAY HAVE A SLIGHT ACCENT, I AM OF SWISS ORIGIN AND OF COURSE NEUTRAL!

OUR FIRST PILOT SCALE TRAILS DATE BACK TO 1984 AND 1985. AT THAT TIME WE EVALUATED DIFFERENT GRAPE VARIETIES,(VERDELET, SEYVAL BLANC, PINOT BLANC, CHARDONNAY, PINOT NOIR) DIFFERENT FINING AGENTS AS RIDDLING AGENTS AND DIFFERENT YEAST STRAINS.

AFTER SCRUPULOUS TESTING AND TASTING WE DECIDED TO BOTTLE TWO DIFFERENT CUVEES, NAMELY CHENIN BLANC AND CHARDONNAY AND INCREASED THE NUMBER OF CASES PRODUCED. IN FACT, ON MAY 28, 1988 WE TOOK THE INITIATIVE AND BOTTLED WELL OVER 1000 CASES, AND ARE JUST ABOUT READY TO RELEASE PART OF IT ONTO THE MARKET.

THE FOLLOWING SLIDES SHOULD GIVE YOU A BETTER UNDERSTANDING OF WHAT IS INVOLVED IN MAKING A SPARKLING WINE FOLLOWING THE AUTHENTIC 'METHODE CHAMPENOISE'.

AS A GENERAL RULE, IN THE CHAMPAGNE AREA, 4,000 KILOGRAMS OF GRAPES PRODUCE 2.666 LITRES OF JUICE OR 'MUST'. THE 2.666

LITRES ARE EQUIVALENT TO 13 CHAMPAGNE CASKS, AND ARE CALLED THE 'CUVEE'. IMMEDIATELY AFTER THE PRESSING OPERATION THE JUICE FLOWS INTO WHAT IS KNOWN AS 'CUVE DE DEBOURBAGE' WHERE IT STAYS FOR TEN TO TWELVE HOURS, THUS ALLOWING THE BOURBES TO SETTLE. AFTERWARDS THIS JUICE IS PUT INTO CASKS OR VATS FOR THE FIRST FERMENTATION WHICH WILL TRANSFORM THE JUICE INTO WINE. THEN THE WINE IS GRADUALLY CLARIFIED BY REPEATED DECANTING THROUGHOUT THE WINTER. (THE WINE IS ALSO TASTED ON A REGULAR BASIS BY THE CELLARMAN).

ACCORDING TO PRINCIPLES THAT DATE BACK TO THE 17TH CENTURY, THE CUVEE CONSISTS OF DIFFERENT BLENDINGS OF 'STILL' WINES.

THEY MAY COME FROM A SINGLE VINEYARD, NEIGHBOURING VINEYARDS OR FROM A VARIETY OF VINEYARDS AND MAY BE FROM THE SAME OR DIFFERENT YEARS. THE OBJECTIVE IS TO ACHIEVE A PERFECTLY HARMONIOUS WINE CREATED IN ACCORDANCE WITH TRADITION. WHEN THE HARVEST IS PARTICULARLY NOTEWORTHY, THE BLENDING CONSISTS OF USING ONLY WINES OF THAT YEAR IN ORDER TO ACHIEVE A VINTAGE WINE OR MILLESIME.

MOST OF THE CUVEES ARE MADE UP OF A COMBINATION OF WINES OBTAINED FROM BOTH RED AND WHITE GRAPES. NEVERTHELESS, IT CAN BE MADE EXCLUSIVELY FROM WHITE GRAPES IN WHICH CASE IT IS

USUALLY CALLED A BLANC DE BLANCS OR FROM RED GRAPES KNOWN AS BLANC DE NOIRS. A PINK OR ROSE CUVEE MAY ALSO BE PRODUCED.

ONCE THE CUVEE HAS BEEN COMPLETED, NATURAL FERMENTING AGENTS, FINING AGENTS AND A SMALL QUANTITY OF CANE SUGAR ARE ADDED IN ORDER TO FACILITATE THE SECOND FERMENTATION, WHICH TAKES PLACE IN THE BOTTLE. THE CONVERSION OF SUGAR INTO ALCOHOL AND CO 2 WILL CREATE THE BUBBLES IN THE WINE.

THE GAS REMAINS IN THE BOTTLE THUS FORMING THOSE DELICATE AND TINY BUBBLES WHICH ARE SYNONYMOUS WITH CHAMPAGNE, THE WINE OF CELEBRATION AND JOY.

THE SECOND FERMENTATION TAKES PLACE VERY SLOWLY IN ORDER TO OBTAIN THE LIGHT PERMANENT SPARKLE. THE AGEING PROCESS, ESSENTIAL TO THE FLAVOUR AND INCOMPARABLE DELICACY, DOES NOT STOP HERE. THE BOTTLES REMAIN IN THE CELLARS FOR AN AVERAGE OF 3 YEARS UNTIL THE WINE HAS REACHED COMPLETE MATURITY. DURING THIS SECOND FERMENTATION A DEPOSIT FORMS ON THE SIDE OF THE BOTTLES. ALL THAT REMAINS IS TO REMOVE THIS DEPOSIT. IN ORDER TO DO SO, THE BOTTLES ARE PLACED IN SPECIAL RACKS CALLED PUPITRE, WITH THE NECKS SLIGHTLY TILTED DOWN. BY DAILY TURNING AND TILTING EACH BOTTLE IN A SPECIAL WAY - THE ART OF REMUAGE.

OVER A PERIOD OF SEVERAL WEEKS, THE DEPOSIT SLIDES SLOWLY DOWN AND COLLECTS IN THE NECK OF THE BOTTLE. AT THE SAME TIME THE BOTTLE IS GRADUALLY PLACED VERTICALLY UPSIDE DOWN. REMOVING THIS DEPOSIT IS THE OBJECTIVE OF DEGORGING.

THE NECK OF THE BOTTLE IS PLACED HEAD DOWN INTO A FREEZING SOLUTION. AFTER 10 TO 15 MINUTES, THE BOTTLE CAN BE SET UPRIGHT, THE DEPOSIT WHICH HAS BEEN IMPRISONED IN A SMALL CUBE OF ICE, IS THEN EJECTED AS THE CORK OR CROWN IS REMOVED. THE WINE THAT REMAINS IS PERFECTLY CLEAR WITH A TRANSLUCENT GOLDEN COLOUR, THE SIGN OF A HEALTHY AND ATTRACTIVE CHAMPAGNE.

THE SMALL AMOUNT OF WINE LOST IN THE DEGORGING PROCESS IS COMPENSATED FOR, BY THE ADDITION OF A SMALL AMOUNT OF MIXTURE CALLED THE DOSAGE OR LIQUEUR D'EXPEDITION, A MIXTURE OF CANE SUGAR AND CHAMPAGNE. THE TYPE OF CHAMPAGNE PRODUCED, IE. BRUT, DRY OR SWEET, IS DETERMINED BY THE PROPORTION OF SUGAR USED. FOR INSTANCE A 'BRUT' WHICH IS THE DRIEST CHAMPAGNE SOLD ON THE MARKET, WILL RANGE FROM 0 - 1.5% RESIDUAL SUGAR, THE EXTRA DRY FROM 1 - 2%, THE DRY (ALSO CALLED 'SEC') FROM 2 - 4%, DEMI-SEC FROM 4 - 6%, AND THE DOUX FROM 8 - 10%.
THE BOTTLE IS THEN CORKED AND A WIRE HOOD ADDED TO HOLD THE CORK IN PLACE.

CHAMPAGNE IS ONLY SOLD AFTER A MINIMUM OF 3 YEARS ON THE LEES, BY WHICH TIME IT IS READY FOR DRINKING. IT IS IMPORTANT THAT THE BOTTLES ARE LAID DOWN SO THAT THE CORKS DON'T DRY OUT.

NOW THAT WE HAVE VIEWED THE HISTORY AND THEORY OF DIFFERENT METHODS OF MAKING SPARKLING WINE, WITH THE HELP OF SOME SLIDES I WOULD LIKE TO ACQUAINT YOU WITH THE METHOD WE HAVE USED AT MISSION HILL VINEYARDS.